A photograph of a lake shoreline. In the foreground, there is a large, smooth, light-colored rock partially submerged in the water. To the left of the rock, there are clumps of tall grasses and smaller rocks. The water is calm and reflects the sky. In the background, a dense forest of tall, thin trees lines the shore under a cloudy sky.

# **Minnesota's Vanishing Natural Shorelines: A Loss that Contributes to Degraded Lake Quality**

**The Natural Shoreline Partnership's  
Statement of Purpose**

**July 2023**

# Minnesota's Vanishing Natural Shorelines: A Loss that Contributes to Degraded Lake Quality

**July 25, 2023**

This report was formulated out of discussions with non-profit organizational leaders and government (state and local) natural resource professionals concerned about the continuing loss of shoreline vegetation, which helps protect clean water, habitat, lakeshore character, and recreation.

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## Executive Summary

Many of Minnesota's lakes are in trouble. About half of Minnesota's natural shorelines have already been lost, and natural shoreline continues to vanish at an alarming rate. We are degrading our lake water quality. Mowed shorelines allow 7 to 9 times more pollutants to enter the lake than a more naturally vegetated shoreline. These pollutants accumulate in lakes, often creating serious water quality problems while also promoting algal blooms and excessive aquatic vegetation. In addition, we are losing valuable habitat for fish – and loons, frogs, butterflies and more. We are losing the beauty of diverse shorelines and the unique character of Minnesota. It is critical that we act, and act now, to protect our vanishing healthy shoreline and recover what has been lost.



We are aware that the status quo is not working. Despite fifty years of state shoreline vegetation standards and local government regulation, the system has failed to adequately protect our natural shorelines. Additional efforts such as education and enforcement have been only marginally successful.

For lake water quality, fish and wildlife communities, and to sustain the health of Minnesota lakes for our recreation and enjoyment, a reasonable natural shoreline protection and restoration goal would be that 75% of a shoreline be unmowed with natural vegetation, consisting of forbs, grasses, shrubs, and trees that is at least 25 feet in width landward from the lake. How can such a goal be achieved?

After listening to many people and organizations about protecting and restoring shorelines, several reoccurring themes emerged. First, local government staff, at the forefront of property owner interactions, need support and additional technical guidance to promote and facilitate shoreline restoration. Second, there is evidence that community leadership development, including civic engagement approaches<sup>1</sup>, can effectively shift social norms towards protecting and restoring natural shorelines. However, it can take time for behavior shifts to successfully establish. Therefore, community leadership development requires continued support and focus to gain and sustain momentum. Third, effective partnerships from neighboring states may provide models to advance protection and restoration of natural shorelines.

Specific actions that could be taken include:

1. Strengthen the relationships between the many organizations with interest in protecting and restoring shoreline. These organizations include state government, local government, statewide non-profit organizations (like MLR, Freshwater Society, Metro Blooms, and MN COLA), and local organizations, such as lake associations.

- a. Work to understand the roles each organization plays in shoreline protection and seek to align these roles to enhance the strengths and capacity of each organization.
  - b. Make a concerted effort to engage in dialogue with local organizations to better understand their needs and use this information to improve guidance, tools, and programs.
2. Improve public outreach with a sustained, consistent message from all partner organizations.
3. Provide more training and outreach opportunities for key audiences including lakeshore landowners, landscape contractors and consultants.
4. Increase one-on-one landowner contacts by supporting grassroots/local efforts and enhancing the capacity of these efforts. Examples of this include the Lake Steward, the Minnesota Water Steward, and the Lawns to Legumes programs.
5. Create incentives for shoreland protection and restoration.
6. Enhance funding to support for shoreland protection and restoration programs.



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## Definitions

*Natural shorelines* – developed and undeveloped shoreline with (1) a substantial portion of the shoreline frontage with trees, shrubs, and natural ground cover, and (2) an aquatic zone with limited alteration and intact plant stands and woody habitat.

*Healthy shoreline* – “one that is sustainable – that is, it has the ability to maintain its structure (organization) and function (vigor) over time in the face of external stress (resilience).”<sup>2</sup>

*Social norm* – “shared standards of acceptable behavior by groups. Social norms can both be informal understandings that govern the behavior of members of a society, as well as be codified into rules and laws. Social normative influences or social norms, are deemed to be powerful drivers of human behavioral changes and well organized and incorporated by major theories which explain human behavior.”<sup>3</sup>





## The Nature of Lakes

Once something is lost, it is often hard and costly to recover. This is true for lakes. Water quality restoration projects for lakes are often measured in the millions of dollars. And unfortunately, lake ecosystems and water quality may fail to recover even after water pollution sources are eliminated or substantially reduced. For Minnesota lakes, phosphorus is the limiting nutrient for algae production<sup>4</sup>. Phosphorus pollution accelerates the rate of lake aging, otherwise known as eutrophication<sup>5</sup>. This means more frequent noxious algae blooms and fish kills, excessive plant growth, and loss of water clarity. Once in a lake phosphorus continues to cycle, degrading lake quality for a long time<sup>6</sup>. Eutrophication can also alter oxygen dynamics within a lake as dissolved oxygen is consumed by bacteria as they feed on dead algae and other organisms<sup>7</sup>.

While water quality restoration is very difficult and often cost-prohibitive, fish and wildlife habitat and scenic character are more easily recovered with personal no-mow approaches or professional expertise at a manageable cost. Private property owners able to access existing lakescaping information or professional assistance can recover their natural shoreland lot by lot, lake by lake. For many lakes, natural shoreline restoration efforts also help to maintain or improve lake water quality.

Minnesota's lake shorelands require a dual approach: 1) protecting natural shorelines and 2) recovering these shorelines where they have been lost.

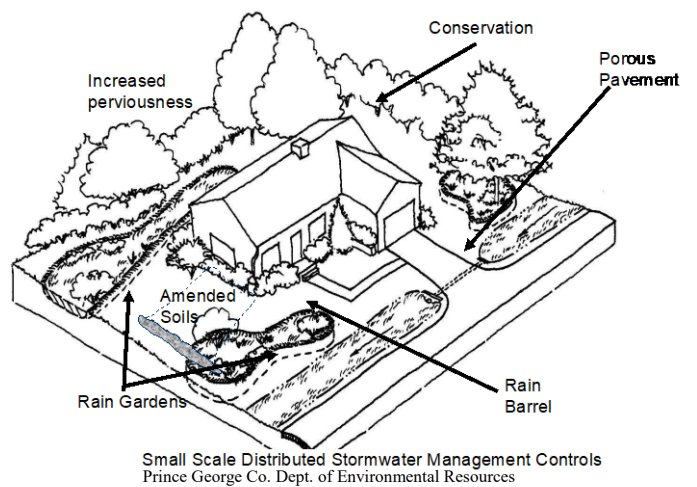
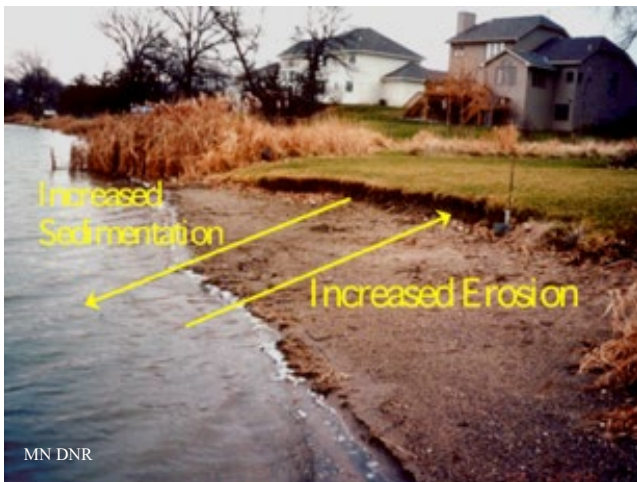
## Benefits of Natural Shorelines

For surface waters, land conditions closest to the water greatly influence water quality. This proximity principle is key to understanding the value of natural shorelines—they are the first and last defense to protect lake and river quality. Natural shorelines are corridors of diverse vegetation along rivers, streams, and lakes which help protect water quality by providing a transition between upland development and adjoining water. Abundant, diverse vegetation holds and filters runoff; stabilizes lakeshores and riverbanks; reduces erosion and limits sedimentation; provides habitat for fish and wildlife; and offers scenic screening of shoreline development<sup>8</sup>.

Plants growing along the shore slow the movement of rainwater runoff. Shore vegetation allows sediment contained in the runoff to settle out and water to infiltrate into the ground near where it falls. Pollutant removal increases with increasing vegetation cover. Near-shore vegetation, such as bulrush, also reduces bank and shoreline erosion. These plants dampen the force of waves, and their deep roots hold the shoreline together. Trees are an important component of natural shorelines. They provide shade, privacy screening, and wildlife habitat. Downed wood, from small branches to whole trees, supplies important habitat for fishes, frogs, turtles, waterbirds, insects, and mammals. Near-shore downed trees also blunt waves and ice action that scours the shore.



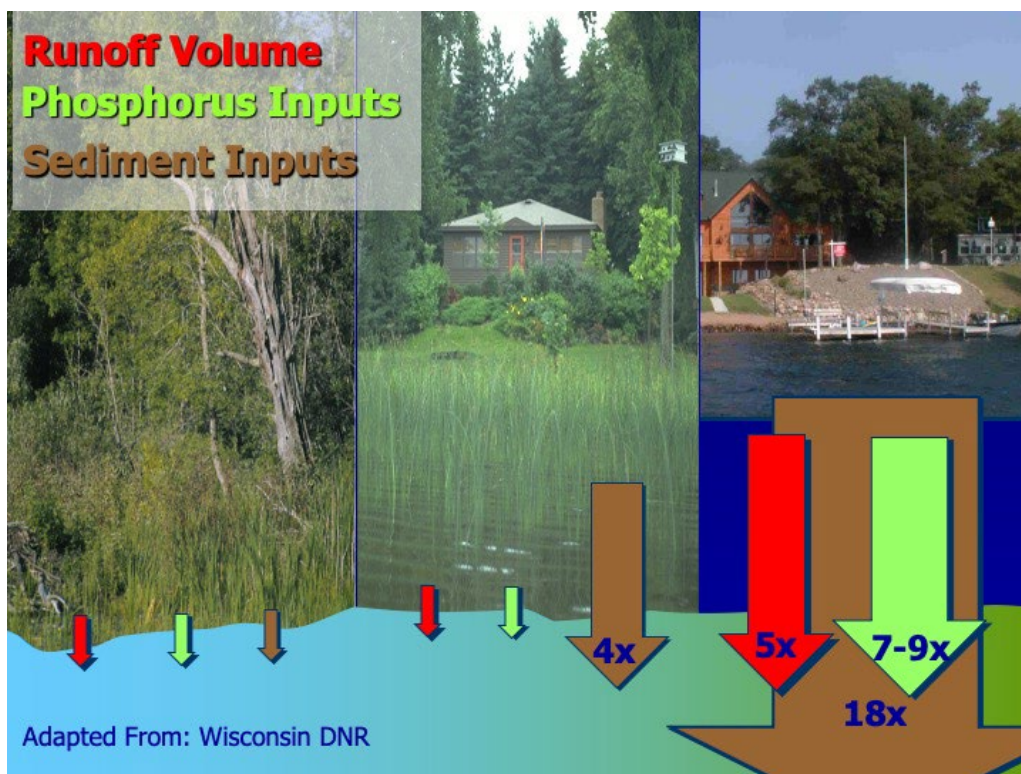
A vegetated shoreline provides benefits besides water quality protection as well. Natural shorelines adapt better to changes in precipitation and changing lake levels, as well as to intense rainfall events. Natural shorelines cost less to maintain both for bank stabilization and scenic benefits. A shoreline buffer, with thoughtfully pruned trees and shrubs, provides a beautiful picture frame for the lake that screens the view of the neighbors.



## Loss of Water Quality

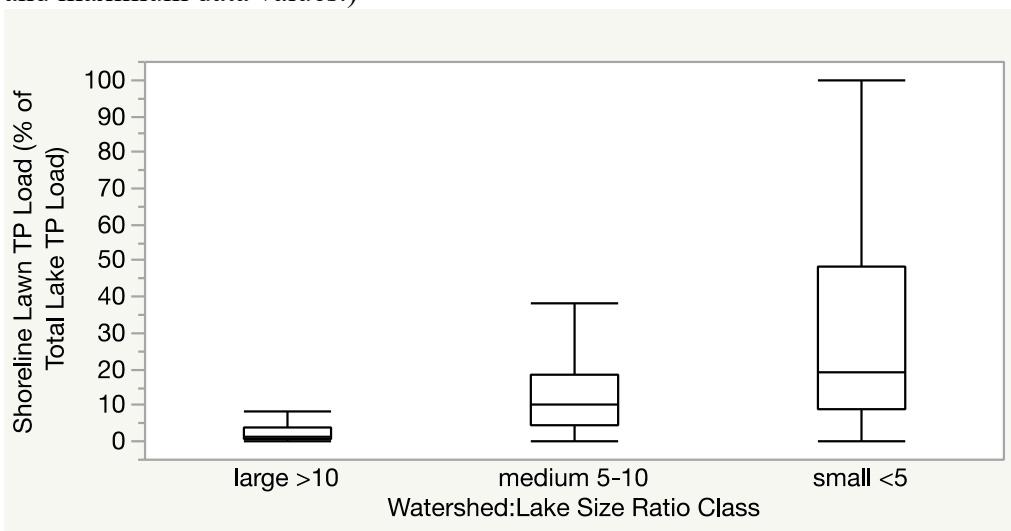
While many lakeshore owners leave or restore native vegetation along the shore, some homeowners plant and mow a lawn down to the lake. The loss of shoreline vegetation leads to high pollution runoff and increased soil erosion. Nitrogen and phosphorus runoff from mowed shorelines is harmful to lakes. Nitrogen runoff promotes nearshore aquatic plants. High nitrogen loads to a lake can reduce plant diversity and increase lake vegetation biomass (which is not a desire of lakeshore property owners). Small additions of phosphorus, a common plant nutrient in Minnesota soils, can lead to large reductions in water clarity. Just one pound of phosphorus added to the lake along shore can produce 500 pounds of algae near the dock and on the swimming beach.

A 'lawn down to lake' shoreline allows 7 to 9 times more phosphorus to enter the lake than a more naturally vegetated shoreline<sup>9</sup>. While the amount of phosphorus entering the lake from shoreline lots varies due to soil, slope, and other site-specific conditions, the average pollution from a 'lawn down to lake' lot has been estimated at 0.2 pounds of phosphorus per summer compared to 0.03 pounds per summer for a lot with a native vegetated shoreline buffer. This increase in nutrient pollution can result in the generation of 100 pounds of algae along one shore lot compared to just 15 pounds under natural conditions. This runoff pollution accumulates around a lake, often creating serious water quality problems. This situation is especially noticeable in those lakes with small watersheds and little or no surface water outflow. The 'lawn down to lake' management style also fragments the shoreline, making it vulnerable to waves from wind and boat traffic. The shallow roots of turf are insufficient to hold the soil, leading to shore and bank erosion.





The lake's watershed to lake size ratio (W:L) explains where the loss of natural shorelines is most important. Research found that lakes with large W:L ratios had a low proportion of their total phosphorus (TP) load due to the loss of natural shorelines. For these lakes, on average 1.5% of the total load came from lakeshore residential lawns and development. However, for lakes with low W:L ratios, on average 19% of the total pollutant load was attributed to lakeshore residential lawns and development, with some lakes having most of their pollutant load due to the loss of their natural shorelines. Lakes with medium W:L ratios had intermediate results; for these lakes, on average 10% of the lake's TP pollution load was coming from lakeshore residential lawns and development. (In the plot below the box represents the interquartile range, the line in the box the median, and the lines that extend from the box are extend to the minimum and maximum data values.)



The results demonstrate the consequential phosphorus pollution from the loss of natural shorelines for lakes with small or medium watersheds. About half of Minnesota lakes have small or medium W:L ratios, so strategies that prioritize the restoration and protection of these sensitive riparian areas are needed to address this source of lake pollution.

## Loss of Water Infiltration

The loss of natural shorelines, with corresponding increases in impervious surfaces and lawns, increases both the amount of runoff and the quantity of pollutants and nutrients reaching lakes and rivers<sup>10</sup>. Our failure to manage rainwater results in erosion and sedimentation, which in turn triggers a series of processes that reduce water and habitat quality. Stormwater runoff is considered a major source of water pollution, and may be responsible for considerable water quality impairment. Perhaps the single greatest threat to lakes from sediment is as a carrier of phosphorus to the lake. In residential areas, the largest source of phosphorus entering lakes is lawn and impervious surface runoff. Rainwater runoff originates from streets, driveways, parking lots, roofs, and other impervious surfaces. Water flowing over these surfaces picks up dirt, nutrients (including applied lawn fertilizer), pesticides, toxic chemicals, pet waste, and other

pollutants. Rainwater that does not infiltrate into the ground or evaporate runs downhill to lakes, wetlands, or rivers.

Rainwater runoff from developed ‘lawn down to lake’ managed shorelines was measured 5 to 10 times higher than from forested shorelines, with a high percentage of storms resulting in runoff. Lawns and urban soils are often very compacted and may act like impervious surfaces in increasing rainwater runoff. Many lakeshore sites have been heavily graded during construction. The depressions and swales that would normally retard runoff are often graded over, the topsoil removed, and the underlying soil compacted, making a flat lawn that acts like pavement in its inability to infiltrate and reduce stormwater runoff. There is a direct relationship between impervious surface coverage and phosphorus runoff pollution. As impervious surface coverage increases, the amount of nutrients entering waters increases. When impervious surface coverage exceeds 10-12 percent of the lake’s watershed (which is typical for suburban/urban Minnesota lakes) without a comprehensive approach to manage rainwater, water quality is generally negatively impacted.



## Loss of Fish and Wildlife

The loss of natural shorelines has a profound effect on fish and wildlife. Many Minnesota lakes are in poor biological condition because of the loss of fish and wildlife habitat<sup>11</sup>, and over one hundred lakes have been listed for aquatic life impairment<sup>12</sup>. Fish diversity and abundance are altered with the loss of shoreline health<sup>13</sup>.

Aquatic plant losses eliminate fish and wildlife habitat. Unhealthy shorelines lead to nutrient pollution, increased water turbidity and reduced deepwater oxygen supplies; these conditions impact both shallow water sight-feeding fish like panfish and bass and deepwater fish like cisco

and lake trout which require abundant oxygen in the cold, deep waters. Changes in aquatic plant communities may also occur with shoreline alterations. Riprap and retaining walls are expensive and negatively affect lakes by creating a barrier between upland areas and the shoreline environment<sup>14</sup>. Poor treatment of the shoreland often corresponds with poor treatment of the aquatic zone. Developed shorelines often have less floating-leaf and emergent vegetative cover than undeveloped shorelines. Elimination of this vegetation also eliminates food and cover for a variety of insects, birds, and amphibians.



Fragmented habitat forces wildlife to spend extra time and energy seeking access to nesting, basking, and feeding sites. Trees, shrubs, and the forest understory near the shore have incrementally declined over time along many developed shorelines. This change in shoreline habitat negatively affects wildlife – although geese appear to appreciate the space, and create a nuisance with their droppings, aggressive behavior, and noise. Loons, however, will not likely nest on a lawn or a beach; they prefer to nest near shore on vegetated hummocks, small islands, or masses of emergent vegetation. The loss of trees along shore means fewer trees fall into the water. Biologists have determined that this loss of trees due to development will negatively affect fish populations for centuries<sup>15</sup>. There is also a definitive link between impervious surface cover and fish. Sedimentation and toxic pollutant runoff to streams and lakes increase with imperviousness, and lead to reduced fish reproductive success and survival. The winter use of salt for sidewalks, driveways, and road deicing results in increasing sodium and chloride concentrations in lakes, which at high concentrations can harm plants, frogs, fish, and other organisms. Within lakes, chloride does not break down or settle out, so this pollution is lasting.



## State of Lake Shorelines in Minnesota

The Minnesota DNR developed a rapid assessment method for objectively evaluating shoreline health for lakes<sup>16</sup>. The Score-the-Shore survey protocol was designed to (1) determine a lakewide lakeshore habitat score with modest precision; (2) detect changes over time, and (3) compare lakewide lakeshore habitat scores to regional patterns and trends.

DNR biologists have conducted these surveys on 785 lakes across the state in association with MPCA's watershed-based monitoring schedule. Each survey site on the lake is scored based on a relative measure of the extent of the natural shoreline present<sup>17</sup>.

**The results from this sample of lakes indicate that Minnesota has currently lost 40 to 50% of its natural shorelines.** Lakes in central Minnesota have lost the most natural shorelines (Figure 1). In this region of the state, about 28% of the lakes had shores that scored low for protection of natural shoreline. Northern Minnesota was more likely to have lakes with high scores. In all regions of the state, most lakes received moderate scores. However, this does not tell the whole story. Recomputing lake scores for only developed shores (parcels with structures) indicated even worse results – for most lakes the developed shore was rated low or very low (Figure 2). A greater percentage of northern Minnesota lakes still had high or moderate scores (48%) compared to central Minnesota lakes (32%), indicating a slight regional difference in shoreline stewardship.

**The rate of natural shoreline loss is estimated to be 1 to 2% per decade<sup>18</sup>.** In time, many of Minnesota shorelines will be damaged and unable to protect water quality and provide sufficient fish and wildlife habitat.

### *A natural shoreline protection and restoration goal*

While the science documenting the habitat and water quality value of natural shorelines is strong, the relationship between the extent of natural shoreline and lake health is complex and studies point to the difficulty in defining a precise threshold at which nearshore habitat and water quality declines for a particular lake. As a result, it is necessary and reasonable to take a precautionary approach in a setting a protection and restoration goal for natural shorelines. This approach acknowledges that nearshore vegetation and shoreline buffers are important to reduce runoff from developed shoreland and to provide critical nearshore habitat. For lake water quality, fish and wildlife communities, and to sustain the health of Minnesota lakes for our recreation and enjoyment, a reasonable natural shoreline protection and restoration goal would be that 75% of a shoreline be unmowed with natural vegetation, consisting of forbs, grasses, shrubs, and trees that is at least 25 feet in width landward from the lake.

Figure 1. Score-the-Shore survey results by DNR administrative region.

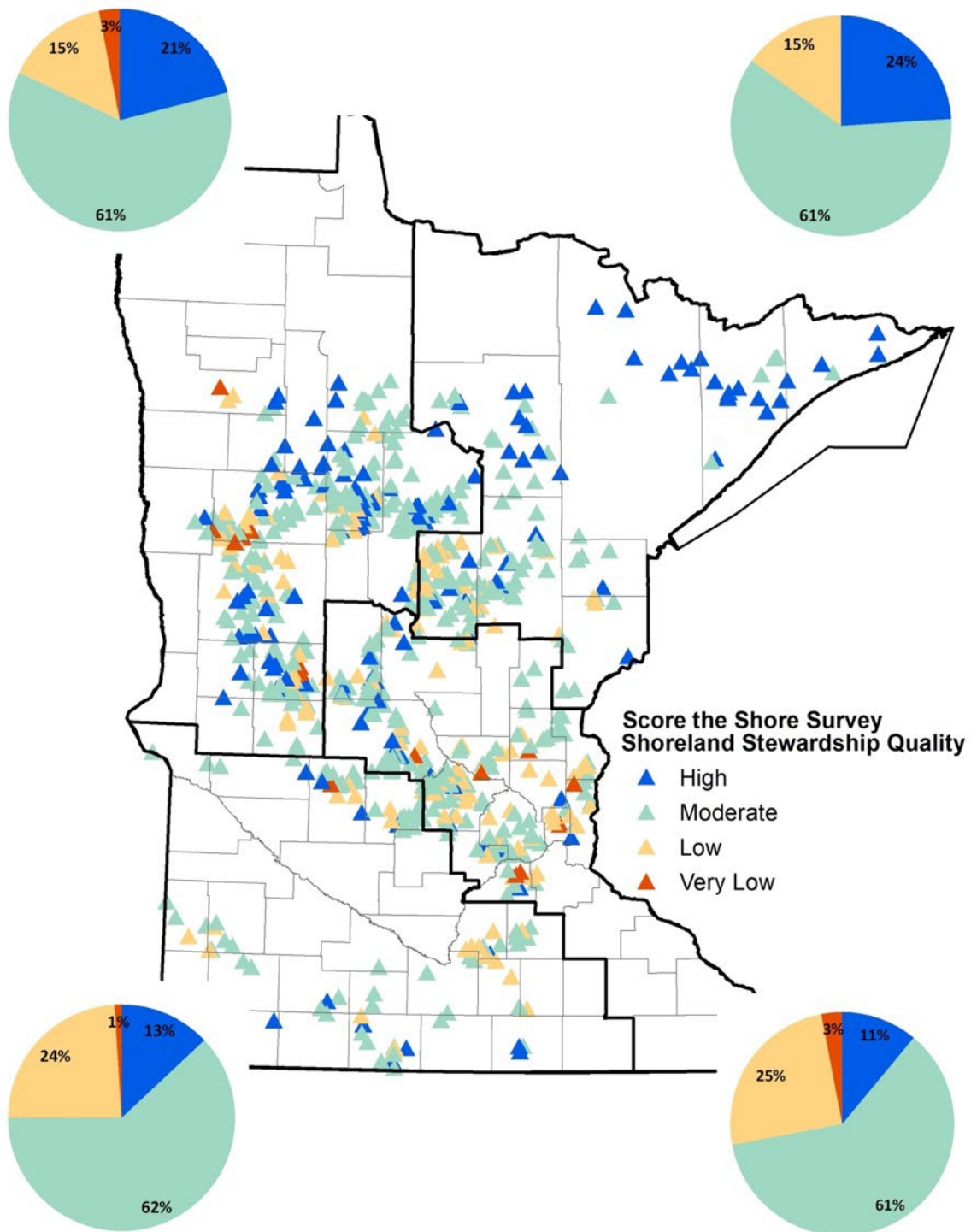
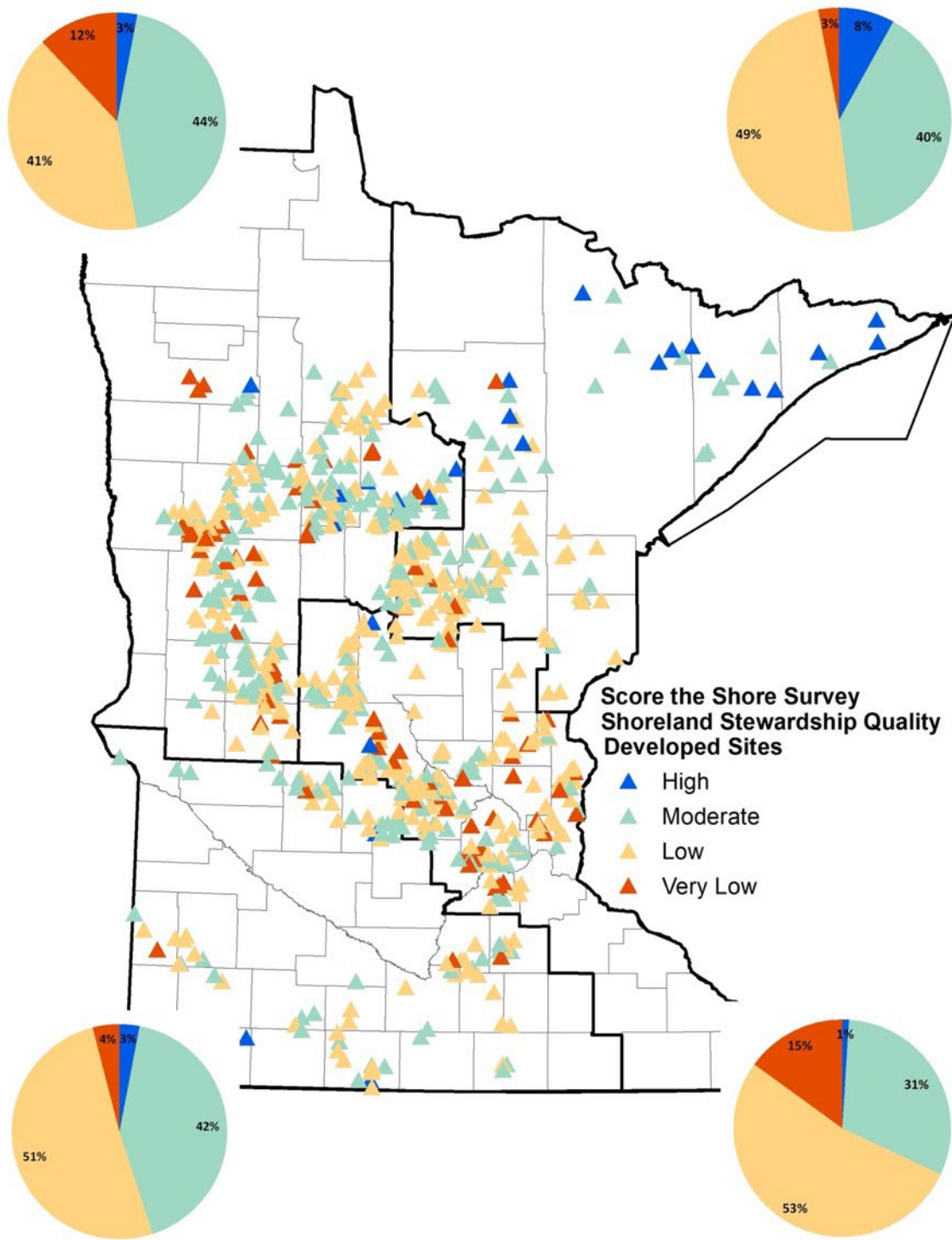


Figure 2. Score-the-Shore survey results by DNR administrative region rescored using only developed shorelands for each lake.





## The Paradox

The Minnesota Legislature has recognized the benefits of natural shorelines by enacting policies to protect them. Minnesota Statutes specify policies to conserve and use water resources in the best interests of its people, and to promote public health, safety, and welfare. It is also the policy of the state to promote the retention and conservation of all water falling from the sky in the areas where it falls. Natural shorelines are critical in achieving these policies, so statewide shoreland development standards (Minnesota Rule 6120) include provisions to protect shorelines from destructive alteration. However, the state of lake shorelands is dire. Regulations have not stopped shoreline alterations, lot by lot, year by year, and lake by lake.

Lakeshore property owners value healthy lakes and clean water<sup>19</sup>. But, there is a paradox: the condition of Minnesota's shorelines suggests that action on the land is inconsistent with this value. Addressing the contradictions between values and actions will require an entirely new approach.

The science and data are available; lack of information is not the issue. The connection between behavior (both individual and collective), knowledge and values is the issue. Understanding and making this connection is critically important. In addition to revised regulations, we believe a bottom-up, community approach is necessary to provide a more comprehensive solution to this environmental problem.

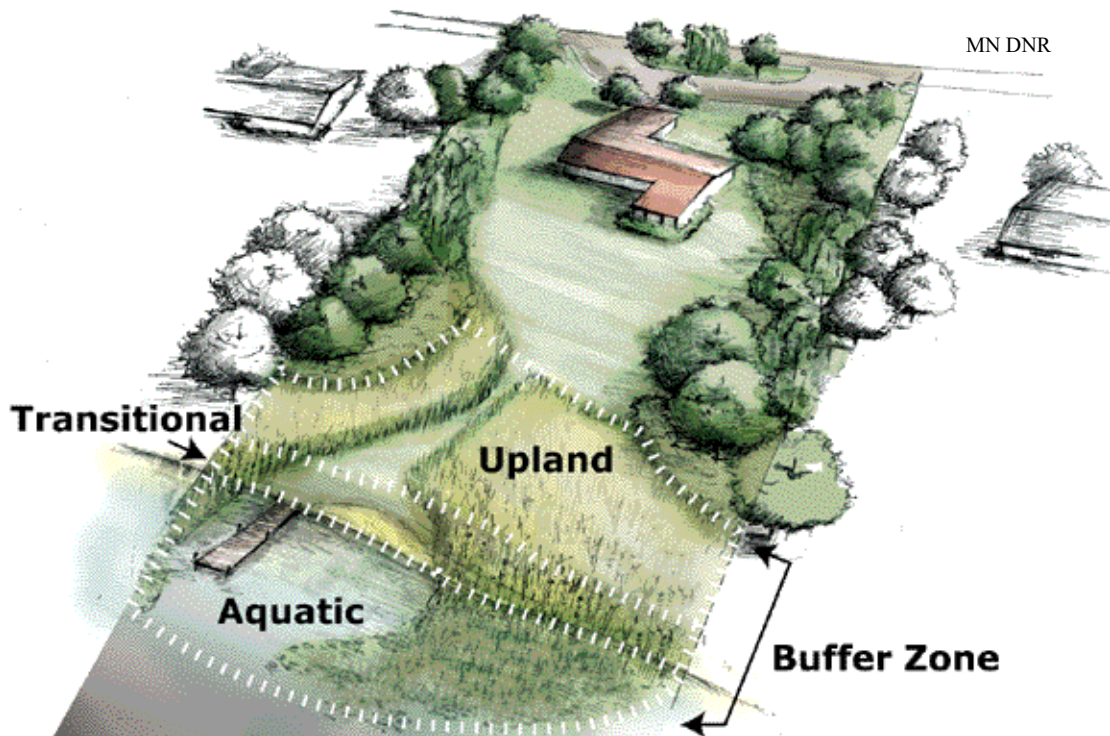


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## Overview of Efforts to Limit Loss of Natural Shorelines

### *Decline in State agency technical guidance for private property restoration*

There are several agencies and organizations that invest in protecting against natural shoreline loss or assisting with the restoration of shoreline. However, there has also been a significant decline of agency funding and associated expertise available for shoreland protection and restoration. The DNR and the University of Minnesota Extension are notable examples of such technical expertise loss. With shifting priorities, this expertise is no longer available to support local governments and private lakeshore property owners requesting assistance on shoreline restoration. The DNR Legacy Fund Restoration Evaluation Report<sup>20</sup> noted that practitioners wanted more trainings to learn from experts. The report also recommended consistent minimum design criteria for lakeshore projects developed with guidance from the few state agency staff with this expertise. Similarly, the DNR 2020 County Shoreland Activity Summary Report<sup>21</sup> reported local government staff requesting more training on shoreline vegetation restoration and professional guidance on land alteration best management practices. These examples indicate a clear need for more technical guidance to local government staff on topics related to restoring shoreline.



### *Loss of DNR funding for private property restoration projects*

Due to funding losses, the DNR phased out direct grants to property owners for shoreline restoration projects.

### *Limitations of State shoreland vegetation standards*

Under the Shoreland Management Act, the DNR establishes shoreland regulations and sets the shoreland development standards for local governments. Counties and cities implement those regulations through local zoning. This approach has a long history in Minnesota. The Shoreland Management Act was passed through bipartisan legislation in 1969, and the shoreland development standards were last updated in 1989. The State's standards and associated criteria were intended to preserve and enhance the quality of surface waters and conserve the economic and natural environmental values of shorelands. However, state and local government officials have long recognized and acknowledged limitations of an exclusively rule-based approach to protect natural shorelands.

The State's shoreline standards afford a basic level of protection. However, they are difficult to enforce due to the enormous scale of the issue and the costs of administering this program, coupled with the limited resources of county and city government. In addition, the state standards allow for the clearing of some vegetation and other shoreline alterations (e.g. riprap and sand blankets), so there can be losses even under the current standards. These standards also do not require restoration of past shoreline alterations.

### *DNR efforts to promote protection and restoration of natural shorelands*

In addition to oversight of shoreland ordinance administration, the DNR encourages voluntary natural shoreland protection efforts. In the early 2000s, the DNR promoted natural shorelines through their "Our Waters-Our Choices" project. The DNR also developed "Restore Your Shore", a do-it-yourself tool for shoreland owners and professionals to guide shoreland restoration and protection projects<sup>22</sup>. Similarly, the DNR created "Score Your Shore", a tool for evaluating habitat on lake lots<sup>23</sup>. Finally, the DNR Shoreland Program highlights and promotes examples of innovative, voluntary higher shoreland standards that local governments have implemented. These include higher standards for shoreline vegetation protection and restoration.

### *Tribal Resource Management Agencies*

Tribal management of natural resources incorporates local ecological knowledge in a cultural context that recognizes a reciprocal relationship with the rest of nature<sup>24</sup>. For example, wild rice is sacred, and cultural practices naturally incorporate protection and regulation of wild rice harvests. As we understand, the protection of water, land, forest, fish, plants, and other natural and cultural resources present on reservations and beyond is a key mission of these agencies. Their responsibilities and values include protecting the many natural resources for the use of future generations.

### *Minnesota Board of Water and Soil Resources (BWSR)*

Through the Reinvest in Minnesota (RIM) Program, BWSR has provided resources to help protect the shorelines of priority wild rice lakes. Lakeshore restoration is being funded through Clean Water Fund grants, as well as the new BWSR Habitat Enhancement Landscape Program (HELP). The Lawns to Legumes program, which is focused on pollinator protection, is also funding shoreline plantings. These efforts will be an increased emphasis of the program through partnerships with Blue Thumb and local conservation organizations.



### *University of Minnesota Extension*

University of Minnesota Extension has engaged in several shoreland protection and restoration initiatives over the past 20 years, including the Minnesota Shoreland Management Resource Guide<sup>25</sup>, which provided information and resources related to sustainable shoreland management practices. Extension created the Itasca Shoreland Advisors Program, in collaboration with Itasca Waters<sup>26</sup>, as a model for engaging local communities in shoreline protection and restoration activities. Extension currently provides information on a variety of shoreland topics to educate shoreland property owners on how to protect and preserve water quality by following best management practices (BMPs) for their property<sup>27</sup>. However, Extension no longer has staff dedicated to a shoreland program.

Recently, Extension has ramped up programming to address aquatic invasive species (AIS) concerns in Minnesota. The AIS Detectors program, launched in 2017, is a partnership between Extension and the Minnesota Aquatic Invasive Species Research Center. The AIS Detectors Core Course and volunteer program empowers Minnesotans to become part of the solution to aquatic invasive species problems by engaging with their communities to share knowledge and best practices. Other offerings of the AIS Detectors program include a virtual course to teach non-professionals about aquatic invasive species management (AIS Management 101), an annual aquatic invasive species early detection event (Starry Trek), a free webinar series, and more<sup>28</sup>.

### *Local Resource Agencies (Soil & Water Conservation Districts, Watershed Organizations, Environmental Services, etc.)*

These local resource agencies provide a critical connection to citizens on the protection and restoration of natural shorelines. Staff assist property owners with technical information, design, cost share, and implementation of stormwater, erosion control, and natural shoreline projects. They have knowledge of local values, organizations, networks and ways of leveraging local capacity that others do not.

### *Local Governments with zoning authority (counties, cities, townships)*

Local governments implement the shoreland standards through local zoning ordinances and are the regulatory authority for land use on the land (above the ordinary high water level). Their work includes administration and enforcement of local shoreland ordinances (e.g., construction, sewer systems, drainage, stormwater management, land alterations, and vegetation removal) and other work on shoreland property that is relevant to water quality.

Many local governments are understaffed in relation to the demand of services. They approve plans and permits for development and work in the shoreland, but often do not have the time to review that the work done was in compliance with the permit or ordinance. Variances are often seen as one of the bigger problems with lake shoreland management. Some local administrators see them as an opportunity to improve shoreland conditions; for example, shoreline restoration for a granted variance may be an appropriate condition to mitigate impacts of the proposed activity. There are also some variance requests that get approved that should have never been approved.

### *Minnesota Lakes and Rivers Advocates (MLR)*

Minnesota Lakes and Rivers Advocates is a non-profit advocacy group focused on protecting Minnesota's lake and river heritage for current and future generations by forging powerful links between lake advocates and policy makers. MLR seeks to leverage the important contributions that lake home and cabin owners and lake associations can make to the preservation of our lakes and rivers.

In the 1990s, through property owner surveys and reviews of taxing data, MLR saw evidence that as property tax pressure on shorelines grew, owners were forced to subdivide and sell shoreline property because it had become unaffordable. In the decade from 2000 to 2010 the average size of a seasonal lot fell by almost 50%, to about 40 acres. To slow this trend and help protect water quality, MLR worked to drive down the class rate on seasonal recreational property until today it is the same as a Homestead. They also worked to extend the Sustainable Forest Incentive Act (SFIA) and the Managed Forest Class rebates and tax reductions to include property adjacent to water. MLR continues to work to create a property tax refund or other incentive to encourage people to go beyond current statutes and manage their shoreline in a way that protects water quality and increases habitat.

In addition, MLR recently launched the Lake Steward program to support lake associations in their efforts to educate shoreland owners and create a shoreline preservation ethic. Shoreland owners that meet 10 criteria for lake stewardship are awarded a beautiful Lake Steward sign to put on their dock. The sign, in addition to rewarding the stewards, helps to shift the social norm (see 'social proof' below). The program was popular in its first summer, with over ten lake associations in various parts of the state participating and hundreds of site visits (the primary shoreland owner educational opportunity) completed. The Lake Steward program creates partnership opportunities with local resource managers and state agency professionals. The Board of the City of East Gull Lake voted to include language promoting Lake Steward on the permit applications for shoreland development. MLR will work to expand the Lake Steward program in the coming years.



### *Freshwater Society*

The mission of the Freshwater Society is to inspire and empower people to value and preserve our freshwater resources. Since 1968, Freshwater has been a leading public nonprofit organization dedicated to preserving freshwater resources and their surrounding watersheds.

The Freshwater Society offers a program that equips and certifies Minnesota Water Stewards, who volunteer their time as local leaders within their communities to support and extend the work of partner watershed districts, cities, counties, and environmental groups. Stewards help improve the health of our waters in a multitude of ways from on-the-ground projects that engage and inspire their communities to participation on city and local government boards where they add their voices to influence policy.<sup>29</sup> Since the Freshwater Society began the Minnesota Water Stewards program in 2013, more than 400 Stewards have been certified and are volunteering their time. These Minnesota Water Stewards have connected with thousands of people through outreach and educational events; installed or planned hundreds of projects, including rain gardens, rain barrels, cisterns, dry creek beds, permeable driveways, prairie restorations, home water audits, school gardens, and library education programs; created art that informs, educates, and inspires others to take action for water; and prevented millions of gallons of polluted stormwater runoff from entering our lakes, rivers, and streams each year.

### *Minnesota Coalition of Lake Association (MN COLA) & Lake Associations*

MN COLA is a volunteer organization with the mission of preserving, protecting and improving the waters and shorelands of the State of Minnesota through advocacy, education, and sharing of best practices. MN COLA provides information and a regular forum for discussion among lake association members from throughout the state. While all issues of lake life, recreation and environmental protection are topics of interest, recent years have been dominated by efforts to improve protocols that prevent the spread of aquatic invasive species. As principal decision makers for private shoreland, Lake Association members and leaders are on the front line to prevent damage to the natural riparian zone by means of Best Management Practices. MN COLA also works closely with MLR for legislative advocacy which includes shoreland issues. There are many lake associations and county lake groups doing excellent work on informing their members about shoreland management issues.

### *Metro Blooms' Blue Thumb—Planting for Clean Water® Education Partnership*

Blue Thumb is a network of clean water and native plant stewards working to bridge the gap between knowledge and action to change landscaping norms by offering resources and programs to residents on pollinator habitat, native plants, rain gardens and shoreline plantings. Blue Thumb partners include local governmental units, non-profit organizations, and private companies. Blue Thumb recently created a shoreland workshop as part of the Lawns to Legumes Program to further engage residents in efforts to protect and restore shorelines.

### *Northern Waters Land Trust*

Northern Waters Land Trust is an accredited, nonprofit land trust working in north central Minnesota to preserve land to protect water through three methods of conservation: land acquisitions, conservation easements, and community engagement and education. Preserving environmentally sensitive land within priority watersheds and shorelines directly benefits water quality by reducing runoff and preventing erosion, which improves resiliency of wildlife habitat,



enhances the local economy dependent on healthy forests, fisheries, and clean waters, and improves overall community health.

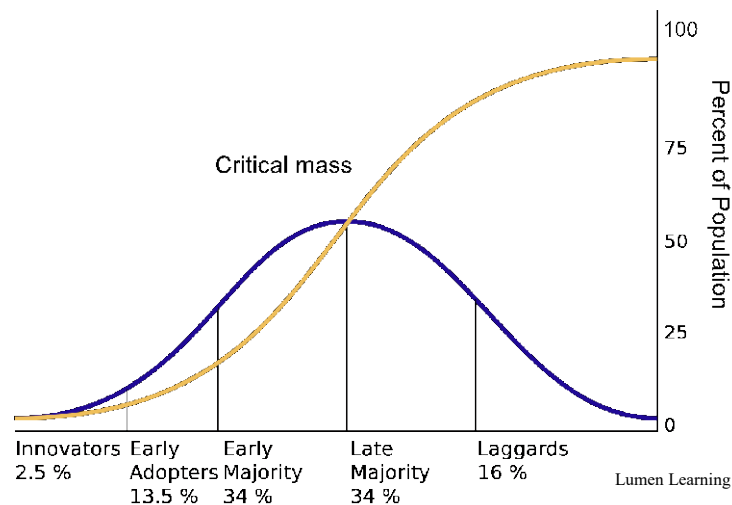
Through community outreach and education efforts, Northern Waters Land Trust aims to change behavior by providing tools and resources to local residents, seasonal property owners, and tourists on how to protect healthy water, shoreline, and shoreland. Conservation easements and fee title acquisitions are mechanisms for permanently protecting lands and waters and can also provide property owners financial benefits. These permanent land protection projects are implemented through collaboration with landowners, lake associations, government agencies, sovereign nations, and conservation organizations.

## Shifting Perceptions of Shoreland Management

Our traditional approaches to protecting shoreland are insufficient. We need to find approaches that shift the social norms around shoreland management and perceptions of a healthy shoreland landscape to better align with people’s stated values of clean water and healthy lakes.

If it is true that the social norm for shoreline stewardship falls on a continuum from a preference for suburban/urban lawn to a deference for nature and a more natural setting and healthy shoreland, the question is: how do we inspire more lakehome owners to shift to a desire for an ecologically friendly approach?

Our conservation problems are social problems, and solutions will require shifting norms and actions<sup>30</sup>. Collaborative approaches to address conservation may be the most effective way to begin working toward changing human behavior and perceptions. Brown (2011)<sup>31</sup> stated, “since wicked problems are generated by the society in which they are set, their resolution will necessarily involve changes in the society that produced them.”



Some people may change their behavior when they are repeatedly confronted with facts, and most people are receptive to the subtle messaging of social norms. Dr. Everett Rogers (1931-2004), *Diffusion of Innovations*<sup>32</sup>, studied how new ideas and practices permeate society and

why some innovations fail to catch on. Rogers noted that when an innovation successfully spreads through a community it generally follows an S-shaped pattern of adoption over time. An innovation is initially slow to catch on, then adoption speeds up as word spreads, and finally there is a leveling off of adoption as the innovation saturates the population. The rate of adoption is usually a function of the innovation. If the innovation has advantages over existing practices, is compatible with values and experiences, is less complex, is easy to experiment with, and has high visibility to others in the community, then it is more likely to have a high rate of adoption.

Rogers identified several important steps in the diffusion of innovation, and he found that to succeed in adoption a person needs: (1) to learn about an innovation; (2) to be persuaded about the merits of the innovation; (3) to try out the innovation, often with experimentation; and (4) to hear confirmation of the innovation's merits from peers (positive reinforcement). Rogers also grouped people into adopter categories: innovators, early adopters, early majority, late majority, and laggards. Naturally, one first needs to focus on the innovators and early adopters to advance the S-shaped adoption curve. Open-minded community opinion leaders and professionals that promote innovations help to speed up diffusion. Peer reinforcement is a key step for success (e.g., the Lake Steward sign programs are based on this principle).

Dr. Robert Cialdini's book *Influence*<sup>33</sup> details seven principles of persuasion, of which six are applicable for promoting natural shorelines. First, reciprocity is when we put ourselves in a position of providing and accepting information. This information may come back to us, as often people have an obligation to give when they receive. Second is 'liking the messenger', which recognizes that we prefer to say yes to those people we like. Third is social proof, in that we will follow the lead of others (the basis of Rogers's *Diffusion of Innovations*). Another is authority. We want to follow the lead of true experts or genuine authorities that we respect. Next is commitment/consistency. When we commit to somebody, we want to be consistent with that commitment. The sixth is unity. We want to say yes to those who are one of us. If these principles are used honestly and with good intent, we can help others to make good decisions and take positive action for Minnesota lakes. The shorthand for all the above is a 'public relationship', and a group or cluster of interlocking public relationships around an issue is the civic infrastructure.

#### *Research on Natural Shoreline Promotion*

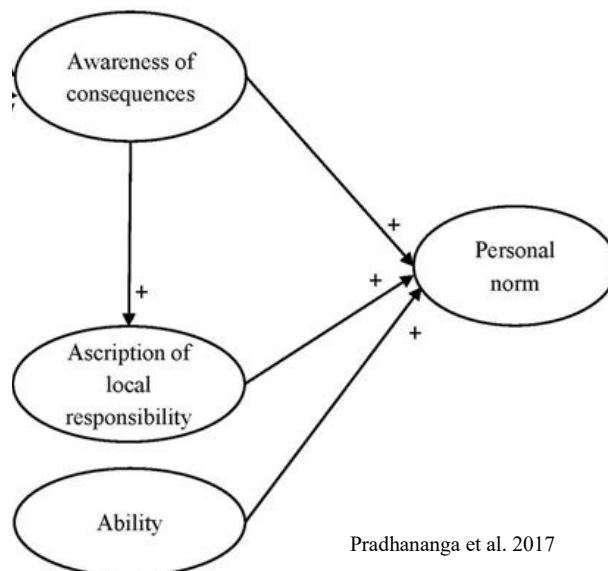
The Native Shoreland Buffer Incentives Project was led by Karlyn Eckman, University of Minnesota<sup>34</sup>. This project used Knowledge-Attitude-Practice (KAP) surveys to determine the best strategies for implementing a natural buffer incentive program in two Minnesota counties<sup>35</sup>. This research found that an understanding of the knowledge, attitudes, and practices already in place among shoreland communities could be reinforced and augmented with strategic incentives to do more. Crucially, the KAP surveys served as the foundation for action toward retaining and restoring a natural shoreline and two counties developed very different programs and results based on the research.

The trial buffer incentive program in East Otter Tail County, administered by the county LGU's shoreland technician, used a Lakeshore Landscaping Manual with design templates. Although participants were provided with workshops, printed material, and a customized approach for individual sites, the scope appeared to have been too large for a single administrator to provide

the hands-on advice necessary for implementation. The Itasca County response to the KAP information was led by Mary Blickenderfer, UM Extension agent and botanist. She developed a peer-to-peer “Lake Challenge” worksheet that was an effective tool used by lakeshore property owners to act. Neighbors from the lake association and college students made the initial contact with an owner and reviewed a series of possible “challenges.” Return visits were aided by the expertise from Extension together with Master Gardeners specially schooled in lakescaping techniques.

Beginning with surveys directed at this specific demographic of lakeshore owners, it was found that the simple offer of cost-shares for specific projects was itself not a major factor in motivation. For those already inclined and challenged to “do the right thing,” the most important incentive was the presence of a true expert who could provide trusted details on a project. Although it can be expensive, such an expert was found to be the most cost-effective aspect. Many lake associations have similar programs that are based on neighbors providing advice on some obvious problems, but without the ability to provide complete solutions. An award is typically provided, such as a sign for the dock or mailbox certifying a promise to do good, backed by peers, and showcase projects can be honored once in place. Again, a willing owner needs project specifics from a natural resource professional, which serves as a motivating incentive to begin.

Drs. Mae Davenport and Amit K. Pradhananga, University of Minnesota, have conducted extensive research on citizen motivations for engagement in water resources protection. They have found that property owners are more likely to engage in protection when they feel a personal or moral obligation to act and perceive that they have the ability to act<sup>36</sup>. Personal obligation was found to be activated by conservation strategies that appealed to a person’s altruistic values, an existing strong land ethic, and unity to their community. Personal norms were driven by individual awareness of the consequences of water pollution, understanding that water resource protection was a local responsibility, and the ability to act<sup>37</sup>.





In 2020, researchers tested the effectiveness of online visuals to shift Lake Sunappe (New Hampshire) shoreline owners beliefs and intentions. They found a positive shift in beliefs and intentions related to lawn fertilization and shoreline buffer creation, suggesting that educational interventions can be useful in shifting personal norms<sup>38</sup>.



## Agents of Change

Given the widespread desire for suburban/urban lawn shoreland landscapes, creating an interest in and desire for ecologically friendly landscapes is a daunting task in need of strong leadership. Changing public perceptions and norms is a challenging effort to which there is no simple solution. We hope this paper encourages a broader conversation of how to effect these changes and suggest these considerations:

1. How can we harness the knowledge, passion, and existing networks of local resource agencies and non-profit organizations to coordinate and amplify efforts?
2. What key messages can be consistently delivered across the state and at the local level to build awareness of the problem and to advance property owner desires for natural shoreline landscapes?
3. What role should state agencies play?
4. What funding is needed to start and sustain this effort?
5. What kind of organization, working within what type of structure, and comprised of what people, is needed to implement the needed messages, programs and local assistance leading to this change?

The answers to some of these questions may be found in studying the work of other organizations that have addressed specific social problems. Following are examples with different organizational structures or frameworks that might provide a path forward:

1. Mothers Against Drunk Driving (MADD) – Independent organization formed for a single, highly-focused mission with funding via grants, corporate and individual donors.

- Seat-belt use and reduced tobacco use are other examples of successful programs to modify social norms.
2. Midwest lake partnerships – Alignment of organizations that collaborate on a shared interest, with members sharing duties in facilitating activities and funding from existing funds or grants.
    - a. The Wisconsin Lakes Partnership consists of the Wisconsin DNR, the University of Wisconsin Extension (specifically *Extension Lakes* - Wisconsin has a robust team of educators housed out of the University of Wisconsin-Stevens Point solely dedicated to preserving Wisconsin’s legacy of lakes through education, communication, and collaboration), and Wisconsin Lakes (a non-profit statewide organization consisting of lake association and lake district members whose mission is to develop statewide solutions for the challenges faced by Wisconsin lakes while supporting strong local protection efforts)<sup>39</sup>. Their Healthy Lakes initiative and lakeshore habitat restoration training for professionals are recent activities<sup>40</sup>.
    - b. The Michigan Natural Shoreline Partnership mission is to protect Michigan lakes through conservation and restoration of natural shorelines. The partnership is a collaboration of state agencies, academia, nonprofit organizations and private industry, formed in 2008. The partnership believes that a change in shoreline development practices is necessary – away from high impact methods that change the natural riparian condition to healthier and sustainable erosion control practices that restore/preserve the ecological function of the shoreline and effectively stabilize shoreline erosion. These changes must include options attractive to lakefront property owners<sup>41</sup>. The Michigan Shoreland Stewards Program provides recognition for lakefront property owners who are protecting inland lakes through best management practices on their property<sup>42</sup>.
  3. New England programs – state efforts that use education and award programs to advance natural shorelines.
    - a. Maine Lakes is an organization that works to protect and preserve Maine’s lakes through education and advocacy. Their LakeSmart program is an education and outreach effort that rewards lakefront homeowners who manage their land to protect water quality. The program is free, non-regulatory, and voluntary. Participating homeowners receive individualized suggestions from trained evaluators for keeping pollutants from stormwater out of lake waters<sup>43</sup>.
    - b. Vermont Department of Environmental Conservation has a Lake Wise Program that awards lake-friendly shoreland property owners. The goal of Lake Wise is to establish a new culture of lakeshore landscaping that is proven to protect the lake. A property that earns the Lake Wise Award will represent a "model" shoreland property. The Lake Wise Award certifies a property is well managed, using shoreland best management practices<sup>44</sup>.
  4. Lawns to Legumes – This program, coordinated by BWSR and supported by a large number of local partners, is focused on supporting at-risk pollinators such as the federally listed Rusty Patched Bumblebee. An emphasis of the program is on building a movement to support pollinators by engaging residents across the state to “Bee the Change” for at-risk species by installing pollinator habitat. The Blue Thumb Partnership plays an important role by leading workshops and volunteer coaching, plus providing cost-share grants to residents. Since 2019 around 3000 projects have been funded, and thousands of

other DIY projects have been guided by the program. Around 6000 residents have also attended program webinars. A lakeshore workshop has been developed for the program and there will be an increased emphasis on engaging lakeshore owners in establishing pollinator habitat and restoring biodiversity<sup>45</sup>.

## Conclusion

We know that the loss of natural shorelines is a problem. We know what we've been doing to address this problem is inadequate. Top-down control through rules, education, and enforcement is not enough. The magnitude of natural shoreline loss is clear and troubling.

We have talked to many people and listened to their stories. The messages are clear and consistent. Riparian owners need more support on shoreline restoration and protection. Community leadership development has proven effective in shifting social norms and values; however, we could better coordinate and invest more deliberately in these efforts. There are organizations and partnerships from neighboring states that might serve as models to help guide work here in Minnesota.

The problem's large scale means there are no easy solutions. We suggest additional discussions and explorations on the following questions:

1. How can the magnitude of the loss of natural shoreline, with the associated negative consequences to lake quality, be better communicated with the general public and those that own lakeshore property across the state?
2. What types of strategies, programs, or initiatives – whether at the local, regional, or statewide level - demonstrate success in shoreline restoration? How can we emulate those strategies?
3. Will additional social science on the social norms of lakeshore homeowners be helpful in better understanding their awareness, attitudes, and obligations to act to protect and restore shoreline?
4. Can a consensus be found to enhance funding to the key agencies that can provide professional expertise and guidance to riparian property owners?





## Online Resources Addressing Shoreland Issues

### **Minnesota Non-Profit Organizations**

[Freshwater Society: Lake Protection and Management Guide](#)

[Freshwater Society: Minnesota Water Stewards](#)

[Lawns to Legumes Program \(Blue Thumb\)](#)

[Minnesota Watersheds](#)

[Northern Waters Land Trust](#)

[Safe Wakes](#)

[Water Legacy: Protecting Minnesota Water Quality](#)

[Stearns County MN Shoreline Restoration](#)

[Minnesota Lakes and Rivers Advocacy](#)

[Itasca Waters](#)

[Deer Lake \(Itasca County\)](#)

### **Minnesota Agencies**

[BWSR Lawns to Legumes](#)

[BWSR One Watershed, One Plan](#)

[DNR Watershed Health Assessment Framework \(WHAF\): Lakes](#)

[DNR Lakes \(General topics and information\)](#)

[DNR Shoreland Management Program](#)

[DNR Maintaining and Restoring Natural Shorelines](#)

[DNR Shoreland Information for Property Owners \(FAQ\)](#)

[DNR Score Your Shore](#)

[DNR Restore Your Shore](#)

[DNR Sensitive Lakeshore Identification](#)

[DNR Landscaping with Native Plants](#)

[DNR Value of Aquatic Plants](#)

[DNR: Lake Improvement Districts \(LID\)](#)

[DNR Shoreland Alteration Information Sheets](#)

[UM Extension: Shoreland Properties](#)

[UM Extension: Water](#)

[UM Extension: Shoreland Care](#)

### **Resources from Beyond Minnesota**

[Burnett County Wisconsin: Shoreland Incentive Program](#)

[Federal Environmental Protection Agency: National Lakes Assessment](#)

[Michigan Inland Lakes Partnership: Shoreland Development](#)

[Midwest Glacial Lakes Partnership: Shoreland Living Booklets](#)

[North American Lake Management Society: Lake Management Planning](#)

[North Central Region Water Network](#)

[Wisconsin DNR Shoreland Management Program](#)

[Wisconsin DNR: Resources on Shoreland Restoration](#)

## End Notes: References Cited

- <sup>1</sup> [https://en.wikipedia.org/wiki/Civic\\_engagement](https://en.wikipedia.org/wiki/Civic_engagement)
- <sup>2</sup> Costanza, R., and M. Mageau. 1999. What is a healthy ecosystem. *Aquatic Ecology* 33:105-115.
- <sup>3</sup> See definition of ‘social norm’: [https://en.wikipedia.org/wiki/Social\\_norm](https://en.wikipedia.org/wiki/Social_norm)
- <sup>4</sup> Carpenter, S. R. 2008. Phosphorus control is critical to mitigating eutrophication. *Proceedings of the National Academy of Science of the United States of America* 105:11039-11040.
- <sup>5</sup> Smith et al. 2014. Comment: Cultural eutrophication of natural lakes in the United States is real and widespread. *Limnology and Oceanography* 59:2217-2225.
- <sup>6</sup> Osgood, D. 2016. Internal loading sustains lake phosphorus impairment. *Lakeline spring*:10-12.
- <sup>7</sup> There are only a few Minnesota lakes that have recovered after phosphorus pollution was substantially reduced. For example, Trout Lake in Coleraine received untreated wastewater from 1910 to 1987, but water quality gradually rebounded after wastewater treatment began in 1987. Deep lakes with low rates of phosphorus recycling are more likely to recover after large reductions in external pollution loading than shallow lakes that generally have high rates of phosphorus recycling from sediments. The reason is that deep lakes stratify during the summer trapping phosphorus in the hypolimnion, except during spring and fall turnover, which is not the case for shallow lakes.
- <sup>8</sup> Bentrup, G. 2008. *Conservation buffers: design guidelines for buffers, corridors, and greenways*. Gen. Tech. Rep. SRS-109, U.S. Department of Agriculture, Forest Service, Southern Research Station, Asheville, NC.
- <sup>9</sup> Radomski, P. J., and K. Van Assche. 2014. *Lakeshore Living: Designing Lake Places and Communities in the Footprints of Environmental Writers*. Michigan State University Press, East Lansing.
- <sup>10</sup> Schueler, T. R. 2003. *Impacts of Impervious Cover on Aquatic Systems*. Watershed Protection Research Monograph No. 1, Center for Watershed Protection, Ellicott City, MD.
- <sup>11</sup> U.S. EPA. 2009. National Lakes Assessment: A Collaborative Survey of the Nation’s Lakes. U.S. Environmental Protection Agency, Publication EPA-841-R-09-001, Office of Water and Office of Research and Development, Washington, D.C.
- <sup>12</sup> See MPCA’s impaired waters list: <https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list>
- <sup>13</sup> DNR. 2018. Stressors to biological communities in Minnesota’s lakes. Minnesota Department of Natural Resources, Division of Fish and Wildlife.
- <sup>14</sup> Riprap should only be used where necessary and never to replace a stable, naturally vegetated shoreline. See DNR handout on natural buffers and lakescaping: [https://files.dnr.state.mn.us/publications/waters/shoreline\\_alterations\\_lakescaping.pdf](https://files.dnr.state.mn.us/publications/waters/shoreline_alterations_lakescaping.pdf)
- <sup>15</sup> Roth et al. 2007. Linking terrestrial and aquatic ecosystems: the role of woody habitat in lake food webs. *Ecological Modelling* 203:439-452.
- <sup>16</sup> Perleberg, D., P. Radomski, S. Simon, K. Carlson, C. Millaway, J. Knopik, and B. Holbrook. 2019. Minnesota Lake Plant Survey Manual, version 3, for use by Fisheries Section, EWR Lake Unit, and EWR Minnesota Biological Survey Unit. Minnesota Department of Natural Resources. Ecological and Water Resources Division.
- <sup>17</sup> Given that the social norm for shoreland stewardship likely falls on a continuum from a preference for suburban/urban lawn to a deference for nature with a preference for a more natural setting and healthy shoreland, the average of the site scores is used to assign the lake’s Shoreland Stewardship Quality class (a ‘High’ classification indicates a lake with a lot of natural shoreland present and a ‘Low’ or ‘Very Low’ score indicates a lake with little natural shoreland remaining).
- <sup>18</sup> This estimate is based on past losses of nearshore and aquatic vegetation and assuming concurrent shoreline losses (Radomski, P. 2006. Historical changes in abundance of floating-leaf and emergent vegetation in Minnesota lakes. *North American Journal of Fisheries Management* 26:932-940).
- <sup>19</sup> Eckman, K., M. Blickenderfer, and S. Henry. 2012. Native Shoreland Buffer Incentives (NSBI) Project: Final Report—Social Research and Efficacy Outcomes. University of Minnesota Water Resources Center.
- <sup>20</sup> See DNR’s Restoration Evaluation Program website: <https://www.dnr.state.mn.us/legacy/restoration-evaluation.html>
- <sup>21</sup> See DNR’s Summary report on County shoreland activity: [https://files.dnr.state.mn.us/waters/watermgmt\\_section/shoreland/county-shoreland-activities-summary.pdf](https://files.dnr.state.mn.us/waters/watermgmt_section/shoreland/county-shoreland-activities-summary.pdf)
- <sup>22</sup> See DNR’s Restore Your Shore website: <https://www.dnr.state.mn.us/rys/index.html>
- <sup>23</sup> See DNR’s Score Your Shore survey details: <https://www.dnr.state.mn.us/scoreyourshore/index.html>
- <sup>24</sup> Bussey, J., M. A. Davenport, M. R. Emery, Marla, and C. Carroll. 2016. A lot of it comes from the heart: the nature and integration of ecological knowledge in tribal and nontribal forest management. *Journal of Forestry* 114:97-107.



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- <sup>25</sup> See University of Minnesota Extension’s archived Shoreland Management Resource Guide: <https://www.shorelandmanagement.org>
- <sup>26</sup> See Itasca Waters website: <https://itascawaters.org>
- <sup>27</sup> See University of Minnesota Extension’s best management practices for shoreland properties website: <https://extension.umn.edu/lakes-and-wetlands/shoreland-properties>
- <sup>28</sup> See Minnesota Aquatic Invasive Species Research Center’s AIS Detectors Program website: [www.aisdetectors.org](http://www.aisdetectors.org)
- <sup>29</sup> See Freshwater Society’s Minnesota Water Stewards website: <https://freshwater.org/minnesota-water-stewards/>
- <sup>30</sup> Rittel, H. W., and M. M. Webber 1973. Dilemmas in a general theory of planning. *Policy Sciences* 4(2):155-169.
- <sup>31</sup> Brown, V.A. 2011. Collective inquiry and its wicked problems. In *Tacking Wicked Problems through the Transdisciplinary Imagination*. Edited by V.A. Brown, J.A. Harris, and J.Y. Russell. Earthscan, Washington, D.C.
- <sup>32</sup> Rogers, E. M. 2003. *Diffusion of Innovations, 5th edition*. Free Press, New York, NY.
- <sup>33</sup> Cialdini, R. B. 2021. *Influence: the psychology of persuasion, expanded edition*. Harber Collins, New York, NY.
- <sup>34</sup> Eckman, K., M. Blickenderfer, and S. Henry. 2012. Native Shoreland Buffer Incentives (NSBI) Project: Final Report—Social Research and Efficacy Outcomes. University of Minnesota Water Resources Center.
- <sup>35</sup> See the Native Shoreland Buffer Incentives website: <https://www.dnr.state.mn.us/nsbi/index.html>
- <sup>36</sup> Pradhananga, A. K., M. Davenport, and B. Olson. 2015. Landowner motivations for civic engagement in water resources protection. *Journal of the American Water Resources Association* 51:1600-1612.
- <sup>37</sup> Pradhananga, A. K., M. A. Davenport, D. C. Fulton, G. M. Maruyama, and D. Current. 2017. An integrated moral obligation model for landowner conservation norms. *Society and Natural Resources* 30:212-227.
- <sup>38</sup> Ward, N. K, M. G. Sorice, M. S. Reynolds, K. C. Weathers, W. Weng, and C. C. Carey. 2022. Can interactive data visualizations promote waterfront best management practices. *Lake and Reservoir Management* 38(1):95-108.
- <sup>39</sup> <https://www3.uwsp.edu/cnr-ap/UWEXLakes/Pages/default.aspx>, <https://wisconsinlakes.org>
- <sup>40</sup> Goggin, P., and P. Toshner. 2016. Wisconsin’s public-private lakes partnership grows new layers. *Lakeline* summer:20-24.
- <sup>41</sup> <https://www.shorelinepartnership.org>
- <sup>42</sup> <https://www.mishorelandstewards.org/default.asp>
- <sup>43</sup> <https://www.lakes.me/lakesmart>
- <sup>44</sup> <https://dec.vermont.gov/watershed/lakes-ponds/lakeshores-lake-wise/what>
- <sup>45</sup> <https://bwsr.state.mn.us/lawns-legumes-partner-resources>