SPECIAL PUBLICATION

Living With a River

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PROVIDED BY: LAKE AGASSIZ REGIONAL COUNCIL
& THE CASS COUNTY SOIL CONSERVATION DISTRICT

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All programs and services provided by these agencies are offered on a non-discrimination basis.

Cover photo: aerial photo of the Missouri River courtesy of Craig Bihrle, North Dakota Game & Fish Department.

Living With a River

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INTRODUCTION

In 2009, the Grand Forks County and Cass County Soil Conservation Districts, along with several other organizations, wrote a guidebook to provide information for people who live in rural areas – the result was the North Dakota Rural Living Handbook. Shortly after the book was completed, the Cass County Soil Conservation District believed a similar book about living with rivers was needed to inform landowners, elected government officials, and citizens about rivers and how rivers function.

The soil conservation districts in North Dakota had been conducting water quality monitoring of rivers and streams for many years, and the results of the monitoring indicated little change in the amount of sediment and pollutants found in rivers. The soil conservation districts were confused because for decades they recognized the improvements farmers and ranchers had made to control erosion on their farms and ranches; therefore, the districts thought because of better conservation efforts there should be less sediment reaching streams and rivers from cropland and ranchland erosion. The National Sedimentation Laboratory, located in Oxford, Mississippi, is just now beginning to understand the reason there has been more sediment in rivers. Recent studies have shown a large percentage of the sediment in rivers is coming from riverbank erosion and not because of the erosion from upland areas.

The North Dakota Forest Service has estimated that 50% of the original native riparian forest in eastern North Dakota has been lost because of agricultural clearing and encroachment, overgrazing from livestock, Dutch Elm disease, and excessive flooding. Because nearly one-fifth of the state's forests occur within 200 meters of a water body, the forested area along rivers is vital to a healthy river. The riparian forest, or the forested area located along the river edge, plays an important role in controlling riverbank erosion, for filtering nutrients, and for trapping pollutants from adjacent lands, and because much of the riparian forest has been lost, it is easy to understand why the amount of sediment and the water quality in our rivers have not improved significantly. In addition, for most North Dakotans wildlife resources are important to their heritage. Rivers and the associated riparian forest are important for wildlife populations because most of the wildlife species in the state depend on rivers for their primary habitat, even though riparian forests comprise less than 1% of the state's area. (ND Forest Service, 2010)

Early settlers to the region were attracted to rivers because they had a natural scenic beauty, were the primary source of water, were a source of wood and fuel, and once were the main source of transportation. It is easy to understand why people settled near rivers. However, river communities in North Dakota that were founded over a century ago continue to grapple with property damages from flooding, especially on the Red River and Sheyenne River in the eastern part of the state. There are many factors that influence the length and severity of a flood, so predicting a flood event and minimizing the damages from a flood is often times difficult.

Any community located on a river can be flooded, even those communities thought to be protected by flood control dams. A flood control dam doesn't always protect cities during the most extreme weather events, and thus we have been given a false sense of security regarding the protection they may provide. The devastating floods on the Souris and Missouri Rivers during the summer of 2011 have reminded us that any community located on a river is vulnerable to property damages from a flood. Dams can't provide the flood protection that they once did because they are filling with sediment at a rapid rate and no longer have the water storage capacity they had when they were first constructed. Furthermore, dams change the river ecosystem – one result is more riverbank erosion downstream from the dam, compounding the degradation of the river ecosystem.

It is hoped this publication and others like it will give people a better understanding of rivers and how they function so that wise management decisions with our river ecosystems will be made by landowners and government entities. Perhaps, someday communities and citizens will be able to admire the natural scenic beauty that attracted the early settlers to rivers in North Dakota over a century ago and at the same time respect the powerful and dynamic forces of rivers. Perhaps then, people will be able to live with rivers.

RIVER Basics

Physical Characteristics of Rivers

River channels are formed and changed by the water they carry, and rivers always flow in a curved or sinuous pattern. Sinuosity is the word used to describe the level of curving in river bends; the bends in the river are also called meanders. The sharpness of the curve is related to the flow of the river. Rivers in broad, flat valleys, such as the Red River Valley, tend to have long, drawn-out meanders. The force of the flowing water will determine how easily the water can cut a bend in the river or if the river needs a curve to slow down water flows. sustained approach to both traditional and digital marketing.

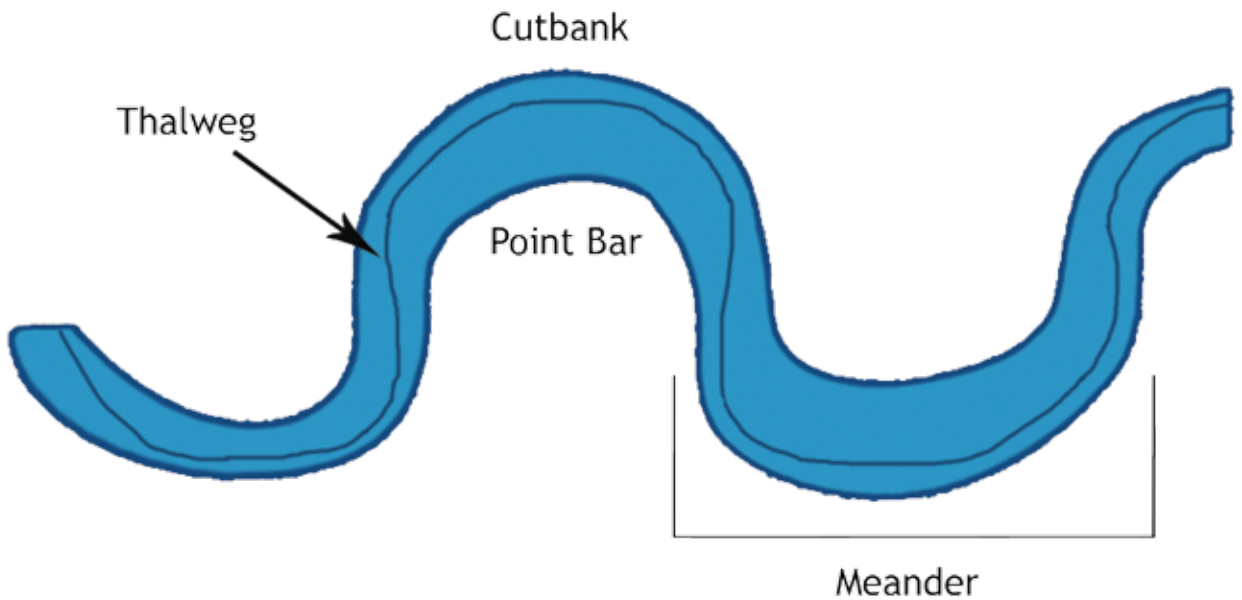


Figure 1. Drawing of a section of a river that offers a visual representation of cut banks, point bars, and meander. The deep blue line in the river is the thalweg or deepest channel of a river, courtesy of the Cass County Soil Conservation District.

The outside bank, also called a cut bank, will cross from one side to the other as the river meanders. Deposition occurs when the water loses sediments, which are materials such as rock, gravel, and soil. Erosion is the process in which materials are removed from the surface of the cut bank. The speed of water is greater near a cut bank, and the faster flowing water in this area makes it more likely for the cut bank to erode. The area of the river where the water flows faster and where the water is deeper is known as the Thalweg. Deposition will occur in an area called the point bar, where the speed is slower. In other words, deposition is most likely to occur on the inside bend of a river.

Figure 2. An aerial photograph of the Red River that shows extreme sinuosity that has caused the formation of an oxbow lake, courtesy of Cass County Soil Conservation District.

Rivers are not only moving downstream, but they are also moving against the outside banks. As erosion **scours** away the cut bank and deposition occurs on the point bar, the river channel moves toward the direction of the cut bank. Over time, the river will become more sinuous. Some meanders will eventually be cut off from the river system and form an **oxbow lake.**

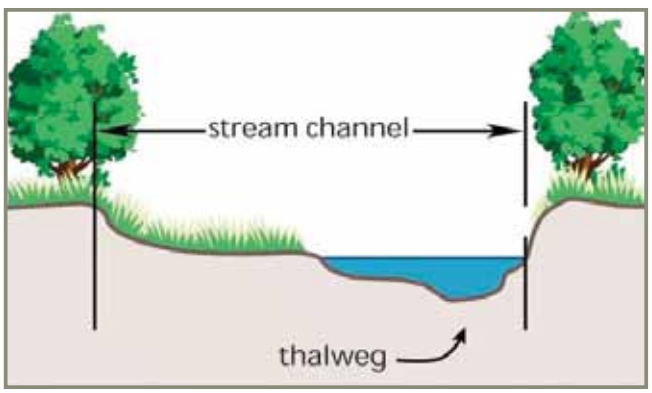


Figure 3. This cross-section drawing shows the expanse of a stream channel, the uneven bottom of a riverbed, and the thalweg. Adapted from Stream Corridor Restoration: Principles, Processes, and Practices, by Federal Interagency Stream Restoration Working Group (FISRWG), October 1998.

Deposition and erosion tend to follow the pattern of the deepest part of the channel, called the **thalweg**, and where the water flows fastest. The thalweg follows the meanders of the river channel, usually hugging the outside bank. As shown in Figure 3, rivers are not flat on the bottom of the channel.

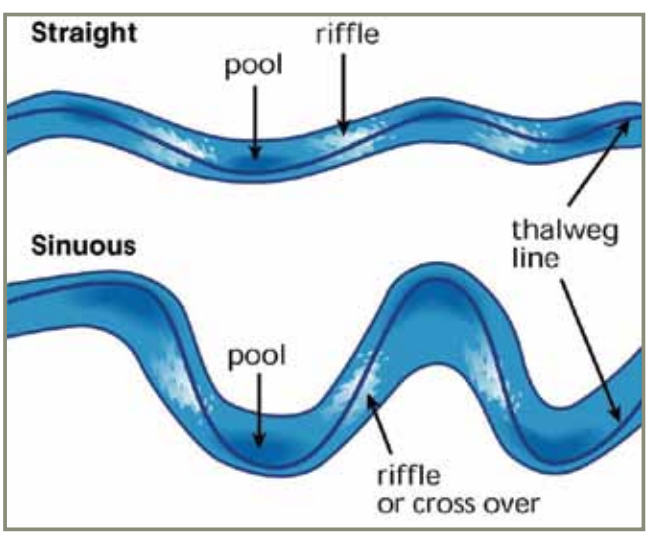


Figure 4. An illustration of sequence of pools and riffles in straight (top) and sinuous (bottom) streams. Adapted from Stream Corridor Restoration: Principles, Processes, and Practices by FISRWG, Oct. 1998.

Enthusiastic fishermen are familiar with the pool-riffle sequence in river channels. The pools and riffles provide different habitat for fish and other aquatic organisms that live in the river. Pools are the areas where the stream channel has managed to scour out part of the channel bottom, creating a deeper pocket of water. Riffles are shallower areas where larger particles, such as rocks and gravel settle to the bottom. Pools are typically found at an outside bend, whereas riffles occur along straighter sections of the river.

River Equilibrium

Rivers are always trying to balance themselves, or, in other words, they are trying to find equilibrium. River equilibrium occurs when four factors are in balance. These factors are **sediment discharge, sediment particle size, stream flow**, and **stream slope.** Because the size of the river's channel is dependent on these four factors, if one of the factors changes, the other factors will increase or decrease to compensate for that change. For example, if city planners decide to straighten out a river's channel to better fit into the city's development plan, the straightened course will allow the water to flow faster because it does not have to move around the original meanders. The faster flowing water will cut deeper into the streambed, which causes more erosion, especially along the outer bank where the water flows are faster, and the river will attempt to create another meander because of the increased erosion of the streambed. The meanders are nature's way of slowing down water in order to protect the flood plain from erosion. The faster flowing water will also carry more sediment downstream, and the additional sediments will build the channel bottom upward, a process called **aggradation**. Loss of sediment cuts the channel deeper, which is called **degradation** or **incision**. The stream in this picture is not at equilibrium. This stream recently went through a period of degradation and scouring, which is often a symptom of flooding. The degradation caused the channel to widen and to cut downward, or, in other words, the channel became more incised. The river is now forming a new **floodplain** within the widened stream channel.

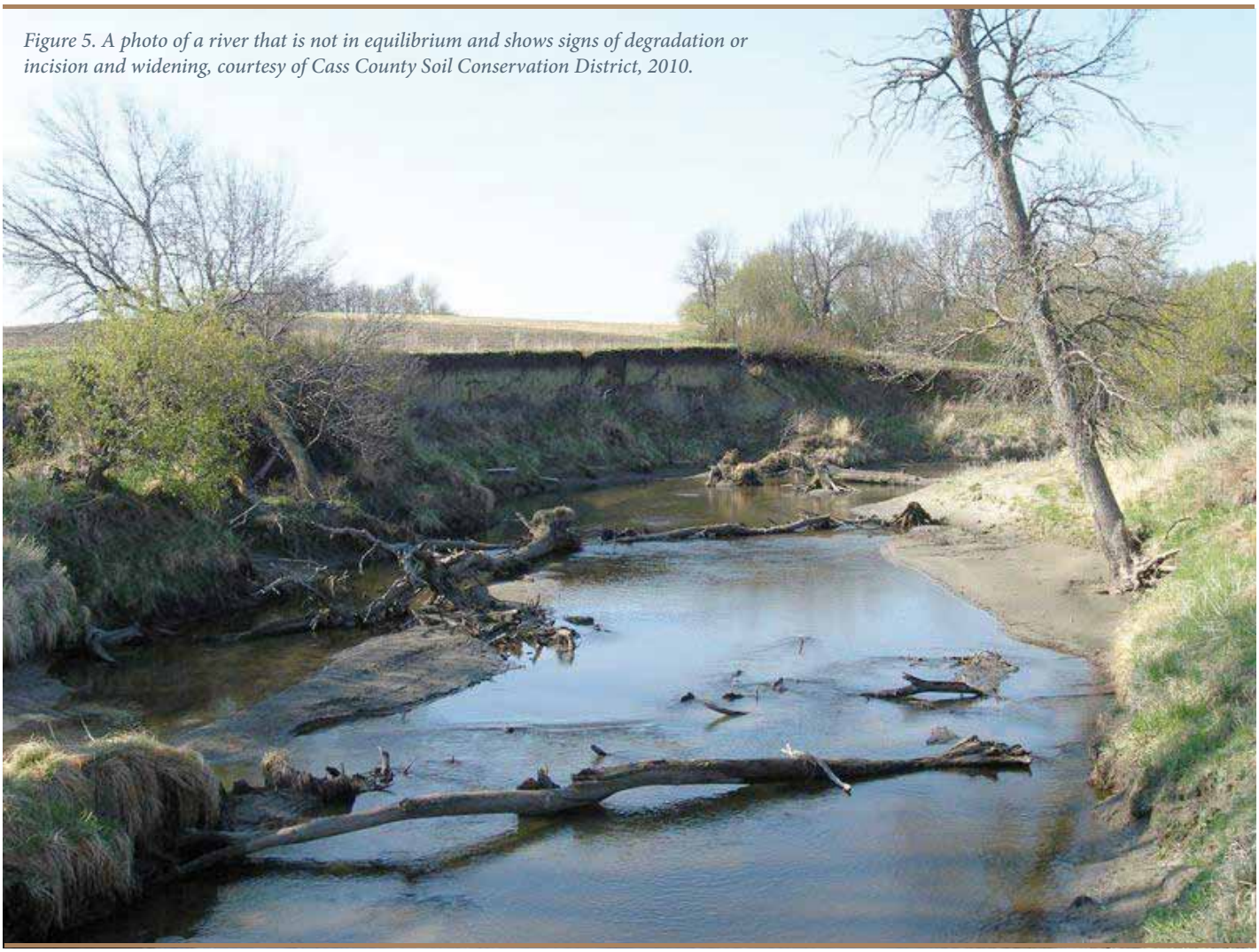


Figure 5. A photo of a river that is not in equilibrium and shows signs of degradation or incision and widening, courtesy of Cass County Soil Conservation District, 2010.

GEOLOGY
of the Rivers in North Dakota

The following information regarding the geological history and makeup of North Dakota's major rivers and tributaries has been adapted primarily from the third edition of John Bluemle's ***The Face of North Dakota***, 2000, with supplementary materials from the North Dakota Geologic Survey, U.S. Geological Survey, and the North Dakota Water Science Center. For more information or additional resources, please check the References at the end of this handbook.

Rivers are important to life in North Dakota. Since the beginning of time, rivers have changed along with the changes in climate and geology. In North Dakota's past, temperate seas, dense swamps, tall forests, and thick glacial ice have all covered the state. It was during the time of the last glaciations, which ended about 10,000 years ago, that many of the landforms and water features that we see today were developed. The river flow patterns and geology in present day North Dakota can all be connected to the last glacial period. In fact, before the last ice age, all the rivers in North Dakota flowed northward before massive amounts of sediment moved by the glaciers created a continental divide known as the Missouri Coteau. The Missouri Coteau stretches along the eastern side of the Missouri River in the central portion of North Dakota and north central South Dakota. Today, the major rivers of North Dakota include the Little Missouri, Heart, Cannonball, Knife, Missouri, Souris, James, Sheyenne, and the Red River of the North.

Figure 6. Map of North Dakota Rivers and Major Tributaires. Courtesy of Map Resources.com, 2012

North Dakota Rivers and Major Tributaries

The Little Missouri, Heart, Cannonball, and Knife Rivers

The geology of the Little Missouri, Heart, Cannonball, and Knife rivers are similar. They all currently flow through southwestern North Dakota, an area not affected by glacial ice. During the time of the last glaciations, the glacial ice in North Dakota only advanced from the north to the present day location of the Missouri River Valley. As a result, these rivers are the oldest rivers in the state because glaciers did not affect them.

The Little Missouri, Heart, Cannonball, and Knife rivers have always carried large amounts of sediment from stream bank erosion and from the runoff from nearby uplands, making the rivers appear muddy. In fact, the Little Missouri Badlands formed because of the excessive water erosion. The lake and river sediments in this portion of North Dakota are pinkish siltstone, sand, and clay; and light colored sand overlaid by dark clay. The Little Missouri River Basin also flows through yellow or gray siltstone, sand, clay, and lignite coal. These formations can be seen in the Little Missouri Badlands with the different colored layers of sediment.

The Little Missouri, Heart, Cannonball, and Knife rivers all flowed in a northeast direction toward Canada before the last glacial period. Before glaciation, the Knife and Cannonball rivers drained almost half of the surface water in North Dakota and merged near the present day Devils Lake. The Little Missouri River merged with the Yellowstone River and continued on a northward route toward Canada.

The Missouri River

The Missouri River is the most unique river in North Dakota, geologically speaking, because it is relatively young, and it represents the approximate southern boundary of the glacial advance. The Missouri River was formed during the last glacial period when the glacier created a temporary dam that blocked water flows from the Little Missouri, Heart, Knife, and Cannonball rivers. The water levels from these rivers rose and formed a glacial lake that eventually overflowed to the south and carved the Missouri River channel that we see today. The glacial boundary can be seen from each side of the Missouri River. The land east is geologically young, only thousands of years old and is dominated by a rolling topography with a good drainage pattern. The rolling topography resulted from stalled glacial deposits and is composed of sand, silt, clay, and cobbles. Most of the ground is stable because of the mixture of sand, silt, and clay particles deposited by the glaciers. The land west of the Missouri River was not glaciated and is geologically much older, millions of years old. Some areas in the Missouri River Valley consist of wind-blown sand dunes and well-sorted sands that were laid down by stream melt-water. The different minerals deposited with each layer during different time periods cause the different colors in the sand layers.

The Souris, James, and Sheyenne Rivers

The Souris, James, and Sheyenne rivers have similar geology. These rivers carried vast amounts of glacial melt water and are known geologically as melt water trenches. The larger river valleys that we see today were at times full of flowing water. The surrounding upland areas near the James, the upper reach of the Souris, and the upper reach of the Sheyenne Rivers are dominated by glacial sediments and therefore have a rolling topography. The upland areas neighboring these river valleys were often formed when sand and gravel were deposited by glacial melt water. Today, many of these areas are still abundant sources of sand and gravel.

The lower reach of the Souris River and the lower reach of the Sheyenne River (the area where the Sheyenne enters the Red River Valley) are also similar; these areas are dominated by wind-blown, lake, and stream deposits. The lower reach of the Souris River formed in material deposited into glacial Lake Souris, when flowing water from the river deposited sorted sands on the lake bottom. When Glacial Lake Souris drained, the sands were unprotected due to the sparse vegetation and then strong winds created the sand dunes. A similar process occurred where the Sheyenne River entered Glacial Lake Agassiz in present day Ransom County; this area is known as the Sheyenne National Grasslands. The lower reaches of the Sheyenne and Souris rivers both flow through old lake bottom sediments consisting primarily of silt and clay materials.

The Red River of the North

The Red River Valley is drained by the Red River of the North and is a unique geologic region in the United States and Canada, because the river valley is nearly level. The Red River Valley is drained by a northward flowing river whose waters flow into Lake Winnipeg; waters then flow from Lake Winnipeg into the Hudson Bay via the Nelson River. The Red River Valley predominantly consists of clay-rich sediments that were deposited at the bottom of ancient Glacial Lake Agassiz. During the time of the glacial melt, the streams flowing into Glacial Lake Agassiz were laden with sediments. The larger particles, such as sand and cobbles, generally settled out near the mouth of the river. The silt and clay particles remained suspended in the water of the lake for longer periods before settling to the bottom. Over thousands of years, the clay-rich sediment thickened, and, in some areas of the Red River Valley, the clay sediments are over 100 feet deep. The uniform settling of the silt and clay to the lake bottom is also the reason why the Red River Valley is flat, and this flatness allows flood waters to spill out onto the ancient lake bed in wide, slow-flowing sheets of flood water.

Isostatic rebound is also occurring in the Red River Valley. This phenomenon happens because the glaciers that once covered the area had immense weight that depressed the elevation of the land. The land was depressed more in the northern end of the valley than in the southern valley because the thickness of the ice was greater in the northern end of the valley. As the glaciers receded, the land began to rebound upward, with the northern portion of the valley rising faster than the southern portion. The Red River still flows to the north because the elevation of the land is lower in the northern end of the Red River Valley.

WATER Quality

Water quality is an important issue in North Dakota because much of our drinking water comes from rivers, lakes, and other surface waters that are vulnerable to pollution. Most "pollutants" are found in lakes and rivers as naturally occurring nutrients, but it is the excess amount of a nutrient in a body of water that makes it harmful. Congress has designated the Environmental Protection Agency (EPA) as the authority to set the legal limits for substances that commonly cause harm through the Clean Water Act of 1977. The EPA allows each state to regulate water quality to meet the federal standards. Information about the federal standards is available at www.epa.gov.

North Dakota's state regulatory agency is the North Dakota Department of Health (NDDH). Every-other-year, the NDDH submits a ***List of the Impaired Waters of North Dakota 303(d) and a Water Quality Assessment Report 305(b).*** These reports and general information about North Dakota's water quality standards are available at www.ndhealth.gov/WQ/.

Pollutant = A waste material that pollutes air, water, or soil, and is the cause of pollution.

Why is the water green?

Excessive amounts of nitrogen and phosphorus can lead to **eutrophication**, which is the process of loading a water body with excess nutrients, followed by a bloom of aquatic plants, such as algae. The word ***eutrophic*** comes from the Greek eutrophos, meaning well nourished, with ***eu*** meaning good, and ***trephein*** meaning to nourish. Once the process begins, eutrophication can become a recurring pattern of plant growth and plant decomposition. Plant decomposition will release the nutrients making them available for additional plant growth. Eutrophication is a natural process, but it is often accelerated because of human activities.

Nitrogen

Nitrogen, like phosphorus, is important for normal plant development. It promotes the growth of plants and contributes to a plants dense, bright leaves and flowers. Almost all farms in the United States use nitrogen as fertilizer, and, because nitrogen is soluble in water, it moves across the landscape and into groundwater with the flow of water. In aquatic environments, nitrogen is second only to phosphorus as a limiting nutrient. And like phosphorus, an overabundance of nitrogen will cause excessive plant and algae growth, harming rivers and lakes. Too much nitrogen and phosphorus in the water caused the algal bloom in the Figure 7.

Figure 7. Algae blooms along a river with high levels of nitrogen and phosphorus. Adapted from "Issues: Nutrients" by St. Johns Riverkeeper, 2011.

Phosphorus

Phosphorus is a naturally occurring nutrient found in all plants and animals, and it is essential for plants to convert sunlight into usable energy. In freshwater ecosystems, phosphorus is often the limiting nutrient. Phosphorus can become a pollutant, however, when an excess amount binds to sediment particles and enters a river through storm water runoff, wind, or because phosphorus fertilizers are applied too close to waterways, storm drains, and ditches. The use of phosphorus free fertilizer is a good way to slow down the runoff of phosphorus into nearby rivers. On a bag of fertilizer is a row of three numbers. These numbers indicate the amount of total nitrogen, available phosphate and potash. The middle number is available phosphate and should read "0."

Phosphorus stimulates growth, so when too much phosphorus ends up in a lake some plants and algae grow too quickly. The over-abundance of these plants absorbs much of the oxygen and sunlight needed by fish and aquatic plants below the surface of the water. Additionally, the decomposition of these plants creates a toxic environment for other organisms, and, as a result, the lake's normal ecosystem is dramatically altered. During an experiment in August 1973, a plastic curtain divided Lake 226 in the experimental lakes area in northwestern Ontario, and upper basin allowed nitrogen and carbon into the ecosystem, while the lower basin allowed nitrogen, carbon, and phosphorus. The results can be seen in Figure 8 (Canadian Government, 2010).

Sediments

The amount of sediment in rivers varies naturally depending on the soil type located within a watershed. Watersheds with coarser materials will often contribute less sediment than finer textured soil. The sediment in rivers is often a major pollutant in the United States. It can clog and irritate fish gills, suffocate eggs, bury aquatic insect larvae, and fill in the pore spaces of gravel on a river bottom. Nutrients and toxic chemicals will attach to sediments causing eutrophication and algae blooms. Figures 10 and 11, above, show a waterway suffering from sedimentation and an example of the removal of sediments along a waterway, respectively.

Figure 8. An illustration indicating phosphorus free fertilizer. courtesy of the Minnesota Pollution Control Agency, Minnesota Department of Agriculture, Dakota County, MN 2011.

Figure 9. This photo shows the result of an experiment in Canada. The lower basin of the lake allowed the introduction of phosphorus, which increased the growth of algae dramatically. Adapted from Fisheries and Ocean Canada, July 2010.

Figure 10. A stream affected by extreme sedimentation. Adapted from "Issues: Sedimentation" by St. Johns Riverkeepers, 2011.

Figure 11. Eroding sediments alongside farmland, courtesy of Cass County Soil Conservation District, 2009.

Escherichia coli (E. coli)

Escherichia coli (E. coli) is a type of fecal coliform bacteria found in human waste and other warm-blooded animal waste; therefore, most water monitoring organizations use E. Coli as an indicator species for the presence of fecal bacteria and viruses. If E. coli counts in water are high, a person swimming in the contaminated water is at a greater risk of getting sick from pathogens entering the body through cuts, from swallowing the contaminated water, or if pathogens enter through the skin, nose, mouth, or ears. Many local governments conduct regular testing for fecal coliform bacteria and will post warnings if levels exceed standards and become hazardous.

Figure 12. Public waterways will post warnings when there are E. coli levels high enough to be a risk to animals or humans, courtesy North Dakota Department of Health, 2012.

Pollution Sources

The most difficult issue with managing water for quality is that water flows downhill, away from the source of the pollutant. However, the steps taken to improve water quality upstream will often show improvement downstream. To improve water quality, neighbors on all reaches of the stream must adopt a land use ethic that places a value on proper management practices. Ideally, as water enters a property, it should be of the same quality or better when the water leaves the same property. Proper land use and good management directly affects the quality of water in river ecosystems.

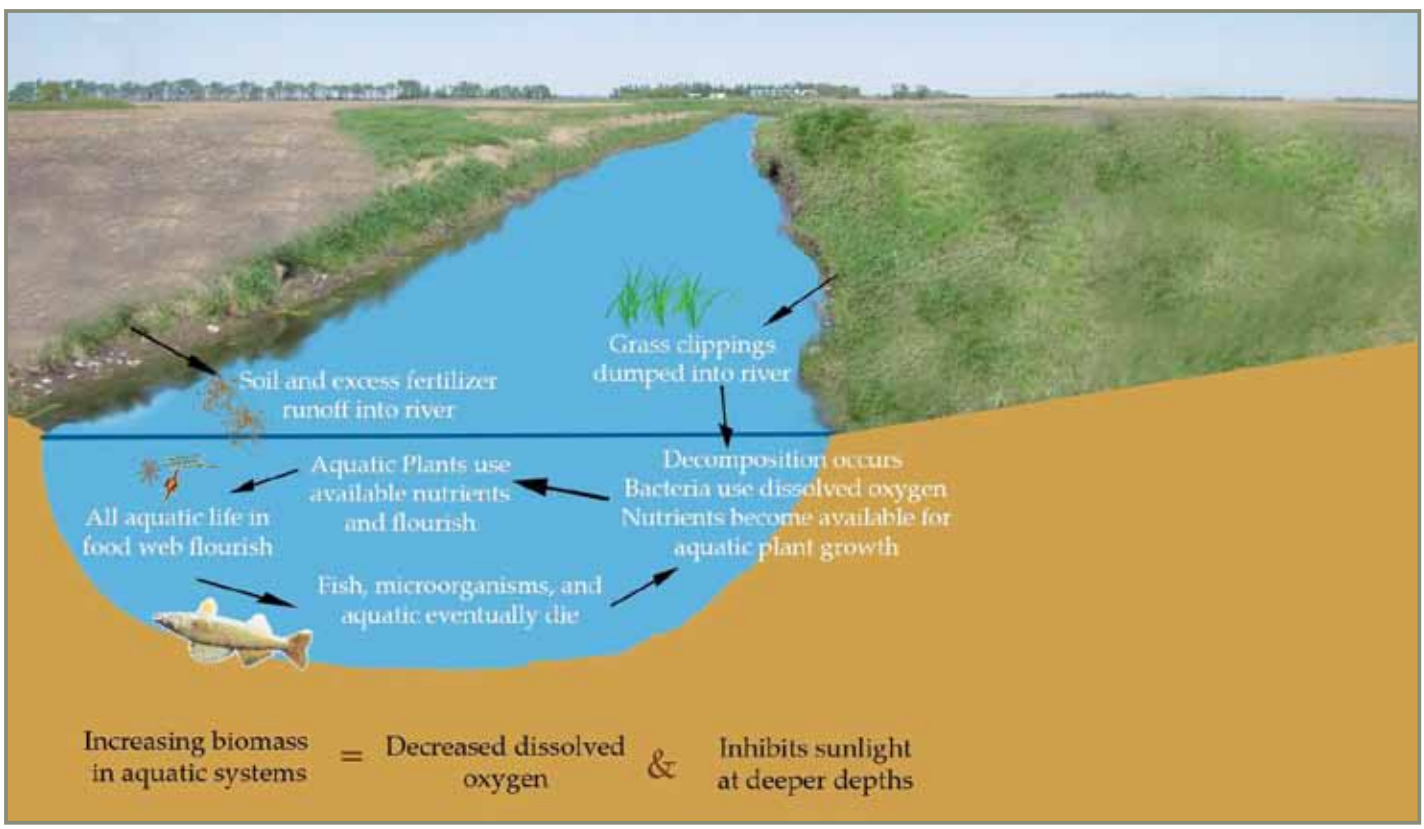


Figure 13. This diagram describes the cycle of river pollution, courtesy of the Cass County Soil Conservation District.

The following table shows the common impairments to North Dakota streams. The source of impairments is indicated, and correcting the source is often the solution. The solutions are often called Best Management Practices.

Common Impairments	Potential Sources of Impairment	Solutions - Best Management Practices
Nitrogen (N)	Dumping leaves and grass clippings Runoff from fertilizer Leaching through groundwater	Mulch or collect and compost lawn clippings Maintain a vegetative filter strip Do not apply fertilizer to frozen or wet soil
Phosphorus (P)	Runoff from fertilizers Runoff from animal waste Sediment loading Use of detergents containing Phosphorus	Maintain a vegetative filter strip Do not apply fertilizer to frozen or saturated soil Sweep dirt off roads and driveways Mulch or seed vegetation on bare soil Use phosphorus free detergents Use phosphorus-free fertilizers
Sediment	Erosion of stream bank Runoff from agricultural fields Runoff from construction sites Runoff from urban areas	Mulch or plant vegetation on bare soil Maintain a vegetative filter strip Use erosion control materials, like silt fences
Fecal Coliform Bacteria/E. coli	Faulty septic systems Poorly managed cattle operations Domestic/wild animal feces	Repair faulty septic systems Rotate cattle through pasture Pick up pet waste in yards
Dissolved Oxygen	Increased water temperature Respiration by aquatic plants/animals Dumping organic matter	Maintain vegetation that shades the water Limit phosphorus loading of nearby water Decrease the speed at which surface runoff reaches the river
Total Dissolved Solids	Runoff	Maintain a vegetative filter strip
Trace Metals	Highway and Road Runoff	Mix, apply, and dispose of chemicals away from pavement, storm drains, and open water
Mercury	Natural sources Deposited from atmosphere, typically through rainfall	Reduce known air pollution production sites

Table 1. Common issues that North Dakota rivers suffer from, the potential sources, and solutions. Cass County Soil Conservation District.

Types of Pollution

There are two types of pollution sources: point source pollution and nonpoint source pollution. Point source is pollution that comes from one identifiable source, such as a leaking septic system. Through the Clean Water Act, point source pollutant sources are permitted and monitored under the National Pollutant Discharge Elimination System (NPDES). Nonpoint source pollution occurs as water flows over the landscape, picking up pollutants. Nonpoint source pollution is not linked to a single source but a broad area, such as urban runoff from street and parking lots.

Figure 14. Nonpoint source pollution gathers near a city storm drain, courtesy of River Keepers, 2012.

Figure 15. A curb marker used to warn citizens of the drainage of storm drains and gutters to nearby river systems, courtesy of River Keepers, 2012.

Lake Winnipeg

Results from water quality sampling and lake-bottom sediment studies show an increase in phosphorus loading into Lake Winnipeg. The lake is also experiencing an increase in the number of blue-green algae blooms. Figure 14, below, offers an example of what can happen when such blooms occur at high rates on large lakes.

To understand the water quality issues within Lake Winnipeg, the whole watershed needs to be examined. The Red River of the North is one of the rivers that flow into Lake Winnipeg and it drains roughly 48,490 square miles. This land is primarily agricultural with a few, large urban areas adjacent to the river (Lake Winnipeg Foundation, 2012).

An international effort is needed to manage the water quality of this watershed. The Red River Basin Commission (RRBC) and the International Water Institute are organizations that address land and water issues in a basin-wide context. For more information on the RRBC, visit http://www.redriverbasincommission.org

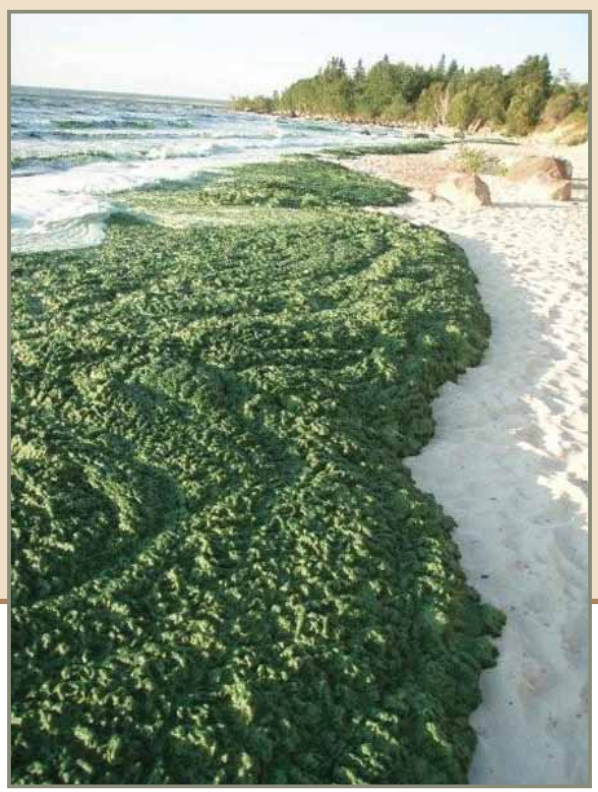


Figure 16. Excessive algae blooms, caused by extremely high levels of phosphorus, wash up on the shore of Lake Winnipeg, courtesy of Lake Winnipeg Foundation and Mavis Whicker, 2010.

BUILDING By A River

While everyone living in the watershed has the responsibility to help keep our rivers healthy, owners of riverfront property are on the front-lines in this battle. Owners of river property may be private individuals, cities, park districts, or state and federal governments. Therefore, it is important that everyone is aware of the issues affecting the river and the proper management techniques that will help to remedy any potential problems.

Riverbank erosion is a natural process and is necessary for proper river health. The natural forces of moving water are always changing river channels. However, many human activities often speed up riverbank erosion, which can harm water quality and threaten property. Many soils in North Dakota, especially in the Red River Valley, have weak engineering properties that enhance riverbank erosion; this erosion is often referred to as slumping. In spite of this situation, areas adjacent to rivers have undergone extensive urbanization in recent years, leading to an increase in the rate of riverbank slumping. The slumping will often result in expensive problems that affect the riverfront owners' land and structures. In some cases, the problems are so severe that the only solution for the owner is to relocate the structure away from the river or tear it down.

Structures are often built too close to the riverbank, where the soils are more susceptible to bank instability. The weight of houses and other structures places pressure on the riverbank, but there is also added pressure on the riverbank because of the weight from increased storm water runoff. The soils weaken more when property owners add moisture from lawn watering and the improper placement of septic drain fields. The added weight from retaining walls, rock riprap, fill, swimming pools, and extensive landscaping places even greater pressure on the riverbank and accelerates riverbank slumping. If the native vegetation is removed from the riverbank, the slumping will increase further because the massive root structure of native vegetation utilizes more moisture keeping the soil drier, and the root systems of native plants bind the soil together.

Hard surfaces, such as driveway pavement, do not absorb or filter the surface water; therefore, hard surfaces will facilitate the transportation of pollutants into nearby waters and allow surface water to gain speed, which causes erosion. Therefore, homeowners should consider ways to reduce hard surfaces on their property. For example, paving materials with openings should be considered that will allow water to directly seep into the soil.

Figure 17. This photo depicts riverbank slumping, courtesy of Cass County Government, 2010.

Figure 18. An aerial photo with an arrow depicting structures built too close to the bank, courtesy of Cass County Government, 2000.

Figure 19. This photo shows dangerous riverbank slumping near residential structures, courtesy of Cass County Government, 2000.

Construction on the floodplain or in the path of the river's natural meander is risky; it is usually impractical and not cost effective to prevent long-term damage to such construction due to the dynamic nature of rivers. Flood control and channel stabilization measures are costly to construct and maintain, difficult to engineer, and are subject to regulations. Gaining a better understanding of how rivers function or seeking advice from people that understand rivers will protect landowner's properties and the river.

Communities that choose to participate in the National Flood Insurance Program (NFIP) are required to adopt and administer regulations that manage development in the floodplain. Mortgage companies will likely inform a buyer if flood insurance is required and insurance agents are trained on issues pertaining to flood insurance coverage. It is recommended that you contact your insurance agent for more information on flood insurance regardless of where your property is located. Flood maps can be viewed by looking up Flood Insurance Rate Maps on the Federal Emergency Management Agency (FEMA) website at http://www.fema.gov/hazard/map/firm.shtm.

The stability of a riverbank is dramatically impacted by the actions all homeowners in a neighborhood. To help reduce the risk of riverbank slumping requires a collaborative effort among all riverfront landowners.

Human Activities that Accelerate Riverbank Erosion

- **Constructing buildings too close to the riverbank.**
- **Adding weight to the riverbank from fill, retaining walls, dikes, roads, and other structures.**
- **Removing native trees, shrubs, and other plants or grasses from riparian areas.**
- **Planting shallow rooted plants near the riverbank.**
- **Mowing a lawn all the way to the riverbank.**
- **Installing septic systems and septic drain fields near the riverbank.**
- **Installing swimming pools too close to riverbank.**
- **Excessive lawn watering from sprinklers and other lawn watering devices.**
- **Farming to the edge of the river.**
- **Allowing livestock continual access to a river.**

IMPORTANT
STATUTES

Landowners that live near a river will likely need a permit from a local, state, and/or federal agency for many riverfront activities, especially construction activities. Because every situation is different, landowners near water may need to contact more agencies than those listed in this chapter. Landowners should begin the permit process well ahead of the scheduled activity, as the approval process may take some time.

Riverbank and Wetland Protection

Riverfront property owners that intend to construct within the riverbed or riverbank will need to obtain a permit issued by the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act. Riverbank protection, such as rock riprap, and structures, such as docks, bridges, water intakes, and fishing piers will require a U.S. Army Corps of Engineers permit. Section 404 permits are also required to place fill material, to drain, or to dredge regulated water areas, including wetlands; or to modify stream channels, riverbanks, or wetlands. The North Dakota State Water Commission regulates statutes, including construction permits, drain permits, sovereign land permits, and water use permits. Riverfront property owners should contact the Natural Resources Conservation Service (NRCS) for information on Swampbuster regulations, which regulate the conversion of wetlands for agricultural production. If a landowner is uncertain whether a permit is needed, he or she should contact the local water resource district.

Water Quality

Use extreme care when choosing and applying pesticides, herbicides, or fertilizers – even small amounts of yard and garden chemicals can be toxic to animals and plants living in or near the river. Chemicals can enter the river either as spray residue or from storm water runoff. Homeowners should avoid using these products near the river or storm drains, and users should exercise caution when applying such products. The responsible application of pesticides, fertilizers, and good management of irrigation water near river areas will protect surface waters and groundwater quality. Remember that an applicator's license may be needed before using some pesticides. While every effort to eradicate weeds that may crowd out native plants and destroy wildlife habitat is good, pesticides need to be applied as directed. See the North Dakota Department of Health's Water Quality Division website for more information: ***http://www.ndhealth.gov/WQ/***. Further information about water quality is explained in the next chapter of this handbook.

Trash Recycling and Disposal

Disposing of waste material in or along rivers, even garden waste, grass clippings, or pet waste can harm riverside vegetation and water quality. According to North Dakota statutes, dumping trees, branches, or yard and pet waste on riverbanks and floodplains is not allowed. It is also illegal to dispose of antifreeze, oil, paint, solvents, detergents, or other chemicals anywhere near rivers. The consequences of improper disposal can be far reaching, especially when the consequences are multiplied by the many thousands of households that use these common substances. Landowners should locate licensed landfills, private trash disposal companies, and recycling centers for the proper disposal of waste. There may also be local ordinances regarding the burning or burying of household trash on private land.

Building Codes and Permits

A landowner should contact the city or county planning department for zoning requirements and permits before any building is constructed. There may be local ordinances regarding the installation of septic systems near a river or regarding distances a building may be constructed from riverbanks.

Buried Utilities

North Dakota law requires everyone to notify utility companies before digging. People should contact the North Dakota One-Call at www.ndonecall.com, call 1-800-795-0555, or 811. North Dakota One-Call will contact the utility line owners in order to locate the location of lines. Landowners need to submit a notice at least two full working days in advance of the project, but no more than a ten-day notice. The first step for any project is safety.

Figure 20. This is the Call 811 logo, which can be seen as part of utility companies' awareness campaigns around the country, courtesy of Call 811 Campaign, 2012.

Wells

Wells in North Dakota need to be registered with the North Dakota State Water Commission, and wells must be constructed to meet North Dakota Well Construction Standards. If there is an abandoned well or a non-functioning well, it is important to have it sealed properly. Unsealed, abandoned wells provide direct pathways for pollutants to quickly enter groundwater, and groundwater is often the main source of drinking water, so protecting it should be important to everyone.

Floodplain Management

North Dakota Century Code, Title 61, Chapter 61-16.2 regulates the use of floodplains.

> The legislative assembly finds and declares that a large portion of the state's land resources is subject to recurrent flooding by overflow of streams and other watercourses causing loss of life and property, disruption of commerce and governmental services, unsanitary conditions, and interruption of trans -portation and communications, all of which are detrimental to the health, safety, welfare, and property of the occupants of flooded lands and the people of this state. The legislative assembly fur ther finds that public interest necessitates that the floodplains of this state be developed in a manner which will alleviate loss of life and threat to health, and reduce private and public economic loss caused by flooding. (North Dakota Legislature, 2011).

Communities are required to submit a floodplain management ordinance adopted under the national flood insurance program to the state engineer for review; therefore, insurance and financing could be impacted in some areas. People considering building near a river should contact the city or county planning department for more information on building restrictions. A complete listing of floodplain administrators can be found on the State Water Commission website: ***www.swc.state.nd.us***

Wildlife Protection and Endangered Species

The law protects threatened and endangered species. Some activities on a property could be affected if threatened or endangered species are present. Landowners may contact the United States Fish and Wildlife Service for more information on threatened and endangered species.

MANAGING VEGETATION
to Prevent Riverbank Erosion

The **riparian** area is the area where the river and land meet. The first step for healthy, functioning riparian areas is effective riparian management. If not managed properly, riparian areas will degrade; therefore, these areas will no longer be able to filter nutrients and sediment before they reach a river, allow water to infiltrate into the ground, stabilize riverbanks from erosion, and provide habitat for wildlife. Degraded riparian areas not only affect the adjacent stream or river but also the entire watershed. **Bank erosion** is the erosion of materials from the sides of a river channel. Moving water often has sufficient energy to move and displace soil materials on riverbanks. The factors that affect the energy of the moving water are the weight of the water, slope of the stream, and the speed at which the water is moving. When the speed of water in the river increases, the ability of the water to erode riverbanks will also increase. Riverbank erosion will often occur during flooding events because of the increased energy of the river water. Riverbank erosion is also more severe when the native vegetation in riparian areas has been removed because native vegetation has strong roots that will absorb the energy of floodwaters and hold the riverbank soils in place. Riverbank erosion is more likely to occur when there is a change in the vegetation in the riparian area, if a river channel is straightened, if there is an increase in the volume of water because of drainage or flooding, or when dam structures are installed on the river.

Figure 21. An example of bank erosion, courtesy of Red River Riparian Project, 2011.

Vegetation is the Root to the Solution

Figure 22. This is an example of native vegetation along the banks of a stream, courtesy of Cows and Fish, 2012.

Maintaining the existing native vegetation or establishing new native vegetation is the best way to protect a riverbank from erosion. Once riverbank erosion has started, it is not easily stopped. Most landowners want a quick fix, and will try various methods, such as placing large rocks or boulders on the areas of an eroding riverbank. At best, this practice will only provide a temporary fix – a better, long-term solution is the maintenance or establishment of suitable vegetation. Healthy, native vegetation will bind the riverbank soil together by providing additional strength because of a strong root system, by absorbing excess moisture and nutrients, and it will slow the speed of river water. Healthy vegetation in the riparian area provides many benefits; it captures fine sediment, filters out pollutants, increases infiltration of water into the ground, provides shade for the river, and provides food and shelter for fish and wildlife.

Maintain the Existing Vegetation

It may be tempting for some landowners to remove existing vegetation from property to create a better view of the river. Anyone who lives close to rivers knows that there is a special kind of scenic beauty in the place where the land and rivers meet. The same attribute that makes these riparian areas special also makes them vulnerable because they are sensitive, easily impaired, and slow to heal once they are impaired.

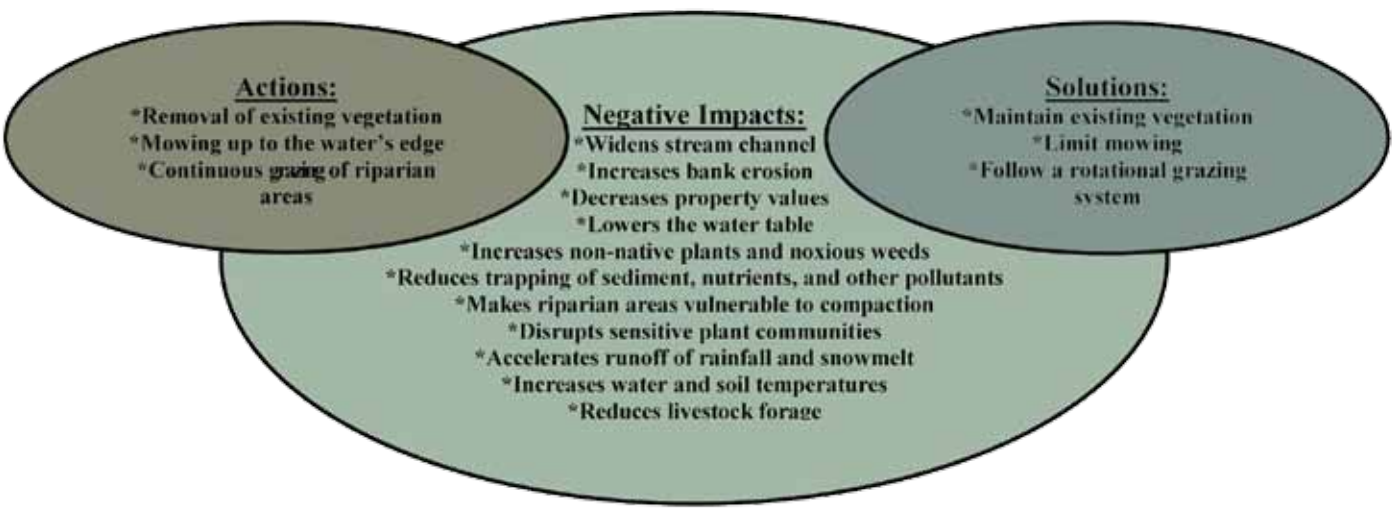


Figure 23. The above illustration indicates the actions of landowners, the negative impacts from the actions, and the solutions landowners will want to consider in order to reduce the negative impacts to stream banks, Adapted from Stream Corridor Restoration: Principles, Processes, and Practices by FISRWG, Oct. 1998.

Protecting the existing, native vegetation along riparian areas is the best assurance for protecting your property from riverbank erosion. This photo shows how bank erosion can threaten property if the vegetation on the riverbank is removed. It is important to avoid mowing too close to the water's edge. The only exception would be for weed control during the establishment of newly planted vegetation. The root development of plants will stop when the above ground portion of the plant is continually removed by mowing because growth of the above ground part of the plant will take priority over root development.

Figure 24. Extreme riverbank erosion likely caused by the lack of native vegetation and frequent mowing to the edge, courtesy of Red River Riparian Project, 2012.

Figure 25. Natural, native vegetation and trees offer not only stability to riparian zones but also picturesque beauty, courtesy of Cows and Fish, 2012.

Figure 26. These views demonstrate the declining roots in grasses from those allowed to rest and recover on the left to those continuously grazed upon on the right. Adapted from "Caring for the Green Zone," Third Edition, Cows and Fish, 2003.

The continuous mowing of a riverbank will cause roots to die and will reduce the vigor of plants. Over time, the plants will become fragile and smaller, resulting in a riverbank that is more vulnerable to erosion. Homeowners may also be tempted to water their lawns, but the excessive watering of a well-manicured lawn will accelerate bank erosion because the soils become saturated and unstable.

It is important to keep a stand of trees in the riparian area for bank stabilization. Roots of trees and shrubs provide added strength against collapsing riverbanks because their roots bind the soil of a riverbank together. The roots of trees and shrubs also intercept surface and subsurface water and filter out sediments, fertilizers, pesticides, metals, and pathogens. The roots of healthy trees can absorb more pollutants than unhealthy trees. People should consider replacing dead or dying trees and shrubs with native species, such as Red Osier Dogwood, False Indigo, Sandbar Willow, or Cottonwood.

Farmers and ranchers should consider limiting access to riverbanks by livestock. This can be accomplished by creating controlled access areas for watering, by fencing systems that that will allow a rancher to establish a rotational grazing system, or by excluding livestock from these areas entirely. Continuous grazing can lead to the destruction of the sensitive vegetation in riparian areas, thus contributing to riverbank erosion. The vegetation is also destroyed because of the trampling associated with uncontrolled access to the river. On the other hand, the complete elimination of grazing by livestock within the riparian area may allow for the invasion of short rooted, undesirable vegetation and noxious weeds. Figure 26 shows the obvious effects to root systems when grasses are not given time to recover from grazing.

Establish Adequate Vegetation

If no cover exists along a riparian area, the homeowner should consider establishing a riparian buffer that consists of native plants. A riparian buffer is the area next to the water that reduces the negative impacts that the adjacent land and the river may have upon each other. A combination of trees, shrubs, and grasses in a buffer 50 to 300 feet wide is the most desirable width to protect the riparian area. Landowners should contact their local Natural Resources Conservation Service (NRCS), the Soil Conservation District (SCD) office, or the North Dakota Forest Service (NDFS) to determine the proper widths of riparian buffers based on the conditions of the site and the landowner goals.

Figure 27. A photograph that depicts a healthy riparian buffer zone, consisting of native grasses, shrubs, and trees, courtesy of Cows and Fish, 2012.

Some landowners may be hesitant to install buffers because of the cost to establish them and the loss of productive land. There are many programs available to assist with the costs of installing riparian buffers. Local NRCS, SCD, or NDFS offices can provide assistance for the design and installation of buffers.

Native Plants

Native plants have evolved over thousands of years in a particular region, and, as a result, they have adapted to the geography, hydrology, and climate of that region. In North Dakota, plants are generally referred to as native if they were here before the arrival of European settlers. The native plants in North Dakota have evolved under a wide variety of conditions including heat, cold, drought, insects, floods, snow, and grazing by bison.

Notice the difference in the size of the root systems in Figure 28; the turf grass roots on the far left are much more shallow and smaller than the native plants. Plants with large root systems help bind the soil and hold it in place. Yet, in most urban areas, one of the most common plants on riverbanks is Kentucky Blue Grass, a common turf grass. Riverbank erosion and slumping in urban areas is often caused by the removal of native plants, followed by the planting of turf grasses. Turf grasses do not have root systems necessary to hold the soil in place. Native vegetation has deep, binding root masses that stabilize stream banks, while shallow roots from common turf grasses and many non-native plants do little to hold the soil in place.

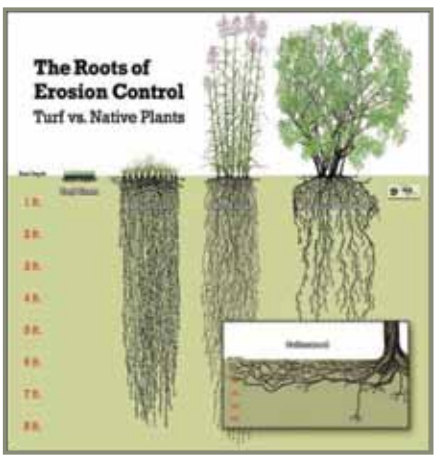


Figure 28. An illustration of the root systems of turf, Buffalo, and Switch grasses, and Redosier Dogwood (left to right) The insert depicts the roots of a Cottonwood, from River Keepers, 2012.

Figure 29. This photo depicts another vegetation community, where the native grasses or turf struggle to maintain the riparian zone, courtesy of Cows and Fish, 2012.

Benefits of Native Plants

- Native plants have deeper root structures that protect the stream bank from erosion.
- Native plants can filter out sediments and pollutants before they reach waterways.
- Native plants reduce flooding by slowing runoff.
- Native plant landscapes are naturally resistant to pests and disease, which reduces the need for pesticides or fertilizers, making the turf healthier for people and pets and increases water quality.
- Native plant landscapes need less water, which saves money and resources.
- Native plants require less maintenance once established which reduces time spent mowing, raking, watering, and using gasoline-powered equipment.
- Native plants provide the best food and habitat for native wildlife, which increases opportunities for wildlife viewing.
- Native plants are hardier than many ornamental plants.
- Native plants reduce problems with weed species.
- Native plants prevent the establishment and spread of exotics (non-native plants).
- Native plants can provide an attractive year-round landscape.

CHOOSING THE RIGHT PLANTS

Plants that are native to North Dakota should be selected when planning a riparian buffer planting. Grasses, trees, and shrubs that are native have evolved over time under local conditions and are adapted to the soils, moisture, and temperature regime found in this area. People considering a riparian planting should research and consult with local nurseries, extension agents, soil conservation district staff, or NRCS staff regarding the adaptability and success of species.

What Do These Terms Mean?

- **Native** – Plants that are part of the original flora of the area in question.
- **Introduced** – Plants that are not part of the original flora of the area in question.
- **Warm Season** – A plant that makes most or all of its growth during late spring, summer, or early fall, and it is usually dormant in winter.
- **Cool Season** – A plant that generally makes the major portion of its growth during the late fall, winter, and early spring (Sedivec & Printz, 2004).

Establishing Native Plants

- Develop a plan based upon research—Attempts to establish any plant, especially natives, will not be successful if the soil type, sun exposure, and drainage conditions are incorrect.
- Check local government regulations before starting—Local weed ordinances or mowing requirements may conflict with your plans.
- Proper ground preparation—Use competent advice on weed control techniques before planting natives. Mowing, hand pulling, and selective use of herbicides are effective techniques.
- Management—Low maintenance does not mean no maintenance. Depending upon the plants, have a plan in place for weed control, deer damage, controlled burns, and mowing.
- Patience—The establishment of a viable native plant community takes time, usually several years.
- Consider using native grasses, such as Big Bluestem, Indiangrass, Prairie Cordgrass, and Switchgrass, in riparian areas.

Figure 30. The early signs of Dutch elm first appear along the edges of the leaves, courtesy of the University of Minnesota Extension service and Janna Beckerman.

When choosing tree species in buffer plantings, special consideration should be placed on the potential each species has for being impacted by diseases and insects. For example, a fungus that is spread either by a bark beetle or by root grafting causes Dutch elm disease. In the early 1970s, Dutch elm disease was discovered in North Dakota, and, since then, it has caused vast destruction of elm trees in North Dakota, many of which were located along rivers. The dead elm trees then contributed much to the woody debris that occurred in riparian areas. Figure 30 offers an example of the early signs of Dutch elm disease.

Figure 31. A photo depicting an EAB adult, courtesy of Michigan State University and David Cappaert.

Another potential threat, specifically to ash trees in North Dakota, is the Emerald Ash Borer (EAB). The larvae of the EAB feed on the inner bark of the ash tree and prevent the tree from receiving necessary nutrients, and eventually the EAB will kill the tree. EAB has already been found in neighboring states east of North Dakota and in some Canadian provinces. According to the Forest Inventory Analysis of the United States Forest Service, ash is the dominant tree species found in the state, and there are approximately 85 million ash trees in North Dakota's woodlands, upland forests, and riparian forests. About 35%, or 30 million ash trees, are located in the state's bottomland forest areas. The North Dakota Forest Service has also estimated that ash trees comprise about 65% of the trees found in narrow riparian areas. This inventory was published in a report titled The Great Plains Initiative (2008-2009). The potential exists for massive destruction of North Dakota's forests from an emerald ash borer infestation. Planting a diversity of other tree species is the best way to reduce the impacts from an EAB infestation (Nebraska Forest Service, 2008).

These are only two examples of why it is important to give serious thought to the types of native vegetation that are used in a riparian buffer zone. To offer stability to riverbanks and riparian ecology, the selected vegetation must be planned to allow for the best opportunity to take root, grow, and flourish throughout the riparian zone as a long lasting and permanent solution.

The charts on the following pages provide guidelines for the proper seeding dates and the native species that are recommended for riparian buffer plantings in North Dakota. ***Seeding rates on grasses were not included because rates will depend on your location and intended use.***

Recommended Grasses

Species (Common Name)	Scientific Name	Varieties	Cool Season or Warm Season	Flood Tolerance[1]	Grazing Preference[1]	Stand Establishment[1]
Western Wheatgrass	Pascopyrum smithii	Rodan, Rosana	Cool-Season	Good	Medium	Medium
Green Needlegrass	Nassella viridula	Lodorm	Cool-Season	Fair	High	Medium
Canada Wildrye	Elymus canadensis	Mandan	Cool-Season	Good	Medium	Rapid
Big Bluestem	Andropogon gerardii	Bison, Bonilla, Sunnyview	Warm-Season	Good	High	Slow
Indiangrass	Sorghastrum nutans	Tomahawk	Warm-Season	Good	High	Medium
Switchgrass	Panicum virgatum	Forestburg, Dacotah	Warm-Season	Good	Medium	Medium
Prairie Cordgrass	Spartina pectinata	Red River	Warm-Season	Good	Medium	Slow

1. Flood Tolerance: Good= 28-42 days; Fair= 14-28 days; Poor= less than 14 days.
2. Grazing Preference: Based on season of rapid growth. Palatability is relative, depending on quantity, quality, and availability of other species. Grazing preference is shown for cattle and will vary for other species of domestic livestock or wildlife.
3. Stand Establishment: Rapid - usually 1 growing season after planting: Medium - usually 1-2 growing seasons after planting; Slow - usually 2-3 growing seasons after planting **(USDA-NRCS, 2008).**

Species Type and Season of Planting

SPECIES TYPE / PLANTING SEASON	NORTH	SOUTH
Cool Season Species		
Spring	Prior to May 20	Prior to May 20
Late Summer	Aug. 10 to Sept 1	Aug. 10 to Sept 1
Late Fall (Dormant)	See Footnote 1	See Footnote 1
Warm Season Species		
Spring	May 10 to June 25	May 10 to June 25
Warm/Cool Season Mix		
Spring	May 1 to June 15	April 1 to June 1

1 Seeding may occur once soil temperatures drop to 40°F for a minimum of 5 consecutive days (usually after November 1) based on ND Agricultural Weather Network or actual field measurements at a depth of 2 inches **(USDA-NRCS, 2008).**

Recommended Trees & Shrubs

Species (Common Name)	Scientific Name	Mature Height (ft.)	Mature Crown (ft.)	Flood Tolerance[1]	Bank Satbilization[2]	Growth Rate[3]	Lifespan[4]	Shade Tolerance[5]
Redosier Dogwood	Cornus sericea	7 to 10	10 to 15	Y	Y	Fast	Moderately Long	Y
False Indigo	Amorpha fruticosa	8 to 12	6 to 10	Y	Y	Medium	Moderately Long	N
Sandbar Willow	Salix interior	6 to 10	5 to 10	Y	Y	Fast	Moderately Long	N
Peachleaf Willow	Salix amygdaloides	40 to 55	30 to 45	Y	Y	Fast	Long	N
Eastern Cottonwood	Populus deltoides	50 to 99	40 to 75	Y	Y	Fast	Long	N
Common Hackberry	Celtis occidentalis	40 to 60	25 to 45	Y	N	Medium	Long	M
Bur Oak	Quercus macrocarpa	40 to 70	35 to 60	Y	N	Medium	Long	N

1. Flood Tolerance: Y= Plants are able to withstand flooding or soil saturation for more than 3 weeks during the growing season.
2. Bank Stabilization: Y= Dense roots stabilize soils and supple tops resist tearing out during high water. If tops are sheared by ice, they readily resprout.
3. Growth Rate: Fast: Greater than 2 feet per year, Medium: 1-2 feet per year, Slow: Less than 1 foot per year. Note: Growth rates assume average weather conditions & appropriate weed control on better soils. Tree growing conditions deteriorate as one progresses from eastern to western North Dakota. Trees & Shrubs in western North Dakota may grow at slower rates than shown.
4. Lifespan: Long= Above ground portions can be expected to survive for greater than 50 years, Moderately Long= Above ground plant parts can be expected to survive for 20-50 years. Lifespan refers only to the survival capability or the originally planted aboveground plant parts.
5. Shade Tolerance: Y= Yes, the plant will grow well in shade, M= The plant is moderately well adapted to growing in shade, N= The plant will not grow well in shade **(USDA-NRCS, 2009)**.

Grasses

Prairie Cordgrass
Plant Materials Center Photo

Western Wheatgrass
USDA-NRCS photo

Big Bluestem
Plant Materials Center
Photo

Switchgrass
Plant Materials Center Photo

Green Needlegrass
Plant Materials Center Photo

Canada Wildrye
Plant Materials Center
Photo

False Indigo
Plant Materials Center Photo

Indiangrass
Plant Materials Center Photo

Shrubs

Sandbar Willow –
Plant Materials Center Photo

Redosier Dogwood (Herman, Stange, & Quam, 2010)

Peachleaf Willow
(USDA-NRCS, 2012)

Trees

Cottonwood (Herman, Stange, & Quam, 2010)

Hackberry (Herman, Stange, & Quam, 2010)

Bur Oak (Herman, Stange, & Quam, 2010)

INVASIVE Species

There are many non-native plants found along rivers and lakes, and some are more invasive and damaging than others. Certain weeds are classified as noxious, and, according to law, they must be controlled. A plant is determined to be noxious by the North Dakota Agricultural Commissioner through consultation with North Dakota State University Extension Service. Noxious weeds are difficult to control, are easily spread through seeds and/or roots, and are harmful to public health, crops, livestock, land, or other property. A complete list of noxious weeds can be found on the North Dakota Department of Agriculture's website at *http://www.nd.gov/ndda/program/noxious-weeds*.

The similarities of some plants can make plant identification difficult. To confirm the identity of an invasive plant, pick the whole plant including some roots, place it in a plastic bag, and take it to your local County Extension Office or Weed Control Officer. Below are some invasive plants and noxious weeds common to riparian areas in North Dakota.

Canada thistle *(Cirsium avvense L.)*
Noxious Weed in North Dakota
A widespread perennial plant that grows in wet conditions. Grows up to four feet tall, spreads by creeping roots or seeds, clusters of purplish whitish flowers.

Photo Credit: Rodney Lym (Lym, 2004).

Purple Loostrife *(Lythrum salicaria L.)*
Noxious Weed in North Dakota
An invasive plant found in gardens that has escaped into moist-marshy areas. A perennial plant 3 to 8 feet tall, spreads by roots, seeds, and stem fragments. This plant forms dense monotypic stands.

Photo Credit: Rodney Lym (Lym, 2004).

Leafy Spurge *(Euphorbia esula L.)*
Noxious Weed in North Dakota
A perennial up to 3 feet tall, spreads by seeds and creeping rhizomatous roots. Roots can grow up to 15 feet laterally and reach depths of over 20 feet. Once established it is very difficult to eradicate. Biological control agents are available.

Photo Credit: Rodney Lym (Lym, 2004).

Absinth Wormwood *(Artemisia absinthium L.)*
Noxious Weed in North Dakota
Widespread invasive plant found on disturbed sites in grasslands, roadsides, etc. Spreads mostly by seed. It is a perennial up to 4 feet tall, With a large taproot and produces a large amount of seed. Crushed plants have a strong sage odor.

Photo Credit: Rodney Lym (Lym, 2004).

Saltcedar or Tamarisk *(Tamarix spp.)*
Noxious Weed in North Dakota
Introduced as an ornamental from Asia. It invades riparian (streamside) areas throughout the American west. It accumulates salt in its tissues, which is easily later released into the soil, making a site unsuitable many native species.

Photo Credit: Rodney Lym (Lym, 2004).

European Buckthorn *(Rhamus calhortica L.)*
Invasive Plant in North Dakota
Buckthorn is a deciduous shrub or small tree that can grow up to 25 feet. The bark is dark gray and the inner bark is orange, which is seen when the tree is cut. Twigs are tipped with a sharp spine. Buckthorn is a native of Europe and was introduced into the United States as an ornamental shrub.

Photo Credits: Tree Bark, Chris Evens (University of Georgia, 2012)., Foliage, Robert Videki, Doronicum Kft (USDA, 2010).

Zebra Mussels

Plants aren't the only types of invasive species that threaten North Dakota rivers. In July 2010, a single Zebra Mussel larva was detected in a plankton sample from the Red River at Wahpeton, North Dakota. While this does not indicate the river is currently infested with the invasive mussel, it does show how vulnerable North Dakota's water resources are to the threat of a Zebra Mussel infestation (adapted from ND Game and Fish website).

Figure 32. A photograph of a Lake Huron specimen of Zebra Mussel, courtesy of the U.S. Geological Survey and Amy Benson, 1992.

Specias and Orgin

"Zebra Mussels and a related species, the Quagga Mussel, are small, fingernail-sized animals that attach to solid surfaces in water. Adults are 1/4 to 1 1/2 inches long and have D-shaped shells with alternating yellow and brownish colored stripes. Female Zebra Mussels can produce 100,000- 500,000 eggs per year, which develop into microscopic, free-living larvae (called veligers) that begin to form shells. After two to three weeks, the microscopic veligers start to settle and attach to any firm surface. It is the only freshwater mussel that can attach to objects. They are native to Eastern Europe and Western Russia and were brought over to the Great Lakes in ballast water of freighters. Populations of Zebra Mussels were discovered in the Great Lakes about 1988" (MN DNR, 2012), and are slowly moving west through Minnesota.

Impacts

A Zebra Mussels infestation will cause problems for lakeshore residents, river residents, and recreationists. Homeowners that use river or lake water for watering lawns can have their intakes clogged. Zebra Mussels attach to boat motors and clog cooling water areas of the motor. Larger Zebra Mussel shells can cause cuts and scrapes when they attach to rocks, swim rafts, and ladders. Fisherman may lose tackle because the shells will cut fishing lines. Zebra Mussels will attach themselves to native mussel species, killing them. Zebra Mussels filter too much plankton from the water, which increases water clarity, and, with less plankton and higher water clarity, more aquatic vegetation will begin to grow at deeper depths. When a lake has high numbers of Zebra Mussels, the excessive filter feeding of plankton impacts the food chain by reducing food for larval fish (MN DNR, 2012).

"Zebra Mussels attach to boats, nets, docks, swim platforms, boat lifts, and can be moved on any of these objects. They also can attach to aquatic plants, making it critical to remove all aquatic vegetation before leaving the river. Microscopic larvae of Zebra Mussels may be carried in water contained in bait buckets, bilges, or any other water moved from an infested lake or river" (MN DNR, 2012).

Figure 33. This aerial photo offers examples of varying riparian zones, courtesy of Cows and Fish, 2012.

RIPARIAN GRAZING MANAGEMENT

The following information regarding riparian grazing management has been adapted primarily from the ***Rancher's Guide to Grassland Management III, 2005***. For more information or additional resources, please check the References at the end of this handbook.

The riparian area is the zone of vegetation located between a stream, river, or wetland and the adjacent upland zone. Riparian vegetation consists of grasses, shrubs, and trees, and it has important functions for filtering pollutants, stabilizing stream banks, buffering flood events, and providing critical habitat for wildlife and fish. The green vegetation in this photo between the river and the surrounding cropland is the riparian area.

Riparian areas in North Dakota and western Minnesota can vary due to differences in weather conditions, geology, and land use patterns. When riparian areas are utilized in conjunction with grazing livestock, we typically call these areas woody draws or bottomland hardwood forests, depending on their location. Riparian areas in central and western North Dakota are usually referred to as woody draws and contain scattered trees, such as American elm, Native Cottonwood, Green Ash, Rocky Mountain Juniper, and Box elder. Shrubs, such as Native Plum, Common Chokecherry, Gooseberry, Wild Rose, Woods Rose, Buffaloberry, Juneberry, and Hawthorne, are also found in the woody draws. The management of woody draws in western North Dakota is usually associated with grazing livestock or hay production in conjunction with the surrounding upland area. In eastern North Dakota and western Minnesota, riparian areas are referred to as bottomland hardwood forests that consist of mature trees including American elm, Native Cottonwood, Green Ash, American Basswood, and Box elder. Bottomland hardwood forests are usually found in association with cropland and, therefore, are fenced and grazed as individual units.

This section discusses grazing management techniques that will sustain woody draws and bottomland hardwood forests in order to benefit the riparian area, including stream bank protection, water quality, and wildlife and fisheries habitat. The grazing techniques will encourage the growth of trees, shrubs, and herbaceous plants necessary for riparian benefits important to ranchers while providing the forage production for livestock grazing.

Riparian Grazing Management in Woody Draws (with a nearby upland pasture)

Livestock are attracted to riparian areas because they provide a source of water, a source of forage that is generally more nutritious during the later months of the grazing season, and shade for livestock. To offset the attractiveness of riparian areas to livestock and to reduce the amount of time livestock spend in the riparian zone, the livestock manager will need to:

1) Change livestock behavior by:

a. Moving salt and mineral away from the riparian zone.
b. Developing fresh stock water sources on adjacent uplands.
c. Installing a drift fence to alter cattle trailing.
d. Reducing the herding of livestock (low stress animal handling).

2) Control the timing of grazing when riparian areas are vulnerable by:

a. Preventing livestock from grazing riparian areas when stream banks are soft in the spring of the year or after major rainfall events.

3) Install a rotational grazing system in order to:

a. Enhance plant vigor, which allows for better bank stability.
b. Provide rest for riparian areas that will allow tree and shrub seedlings to grow to a grazing resistant stage.
c. Minimize the time livestock spend in the riparian area by installing additional fence.

Figure 34. This photo depicts an example of offsite watering, courtesy of Cows and Fish, 2012.

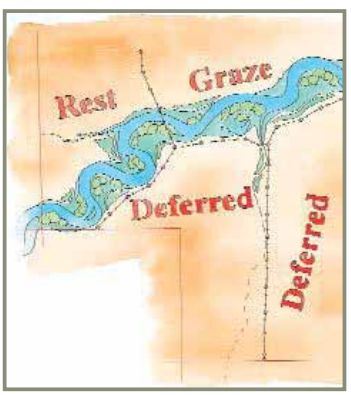


Figure 36. This illustration depicts a deferred grazing plan, adapted from "Caring for the Green Zone - Third Edition" by Cows and Fish, 2003.

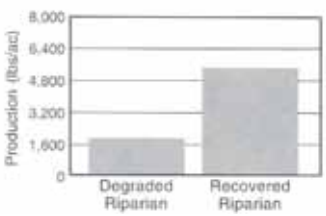


Figure 35. This graph shows the increase in forage production using rotational grazing, in "Rancher's Guide to Grassland Management III" by Sedivec & Printz, 2005.

If a Stream is to be Used as a Water Source

1. Provide ease of access to the riparian area by installing gravel or by hardening the access points that livestock prefer. Stone riprap has been installed in the area shown in this photo to protect a riverbank.

2. Develop riparian pastures by fencing the riparian area into a separate pasture, with separate management objectives and strategies.

3. Install an exclusion fence. Although this is not a favorable option, the exclusion fence will prevent livestock access to high risk or chronic problem areas and will allow for the reestablishment of riparian vegetation.

Figure 37. A photo showing the use of riprap along a stream, courtesy of Cows and Fish, 2012.

Riparian Grazing Management in Bottomland Hardwood Areas (without adjacent upland pasture)

Managing grazing in bottomland hardwood forests is difficult because it is hard to maintain and regenerate the over-story trees in pasture. This is particularly true where a usable upland pasture is not nearby. If a rancher's main goal is to maximize forest health and production, a season-long livestock grazing system is not compatible because the growth of forages in bottomland hardwood forests is less productive than woody draws or upland pastures. The forage production in bottomland hardwood areas can be highly variable, so proper stocking rates should be determined on-site. Livestock injury because of downed woody debris and uneven ground is also more common in bottomland hardwood pastures. Even though the management options are limited for bottomland hardwood forests, the impacts on these areas can be reduced with proper management.

1. Reduce livestock impacts on bank stability by:

a. Providing off stream watering points.
b. Providing ease of access through graveling or hardened access points that livestock will prefer to use.

2. Develop rotational grazing system to:

a. Enhance plant vigor, which allows for bank stability.
b. Provide rest and deferment for riparian areas that allow tree and shrub seedlings to reach a more grazing resistant stage.

3. Develop additional forage in adjacent uplands by:

a. Converting adjacent marginal cropland into spring or summer pastures.
b. Planting high producing forage crops.

Figure 38. A photo clearly showing a riparian buffer zone of native vegetation between cropland and stream, courtesy of Cows and Fish, 2012.

Additional Tips for Grazing Riparian Areas

- **Control the frequency and intensity of a grazing. This will give plants time to recover after a grazing event and is the best overall grazing management strategy.**
- **Install off-stream water sources. Off-stream water sources reduce the time livestock spend in streams by up to 89% and in riparian areas by 51%. Cattle prefer drinking from a fresh water source up to 92% of the time, compared to drinking from a stream. Stream bank erosion is reduced by up to 77% when off-stream water sources are utilized. Source: Sheffeild. 2003.**
- **Install a rotational grazing system to allow limited grazing periods in the riparian area. This will minimize damage during vulnerable periods.**
- **Riparian pastures increase the rancher's control over the grazing process, including the numbers of livestock, season of grazing, and length of grazing and rest periods.**
- **Change the season of use from year to year. This will allow pastures to be grazed at a different time every year. A rotational grazing system involves a planned sequence of grazing and rest periods.**
- **Monitor the livestock diet and/or grazed stubble heights of forages so that livestock can be moved when the quality of herbaceous plants drop below the quality of the woody vegetation in the pasture. This will reduce the browsing of woody species by livestock (Clary & Leininger, 2000).**

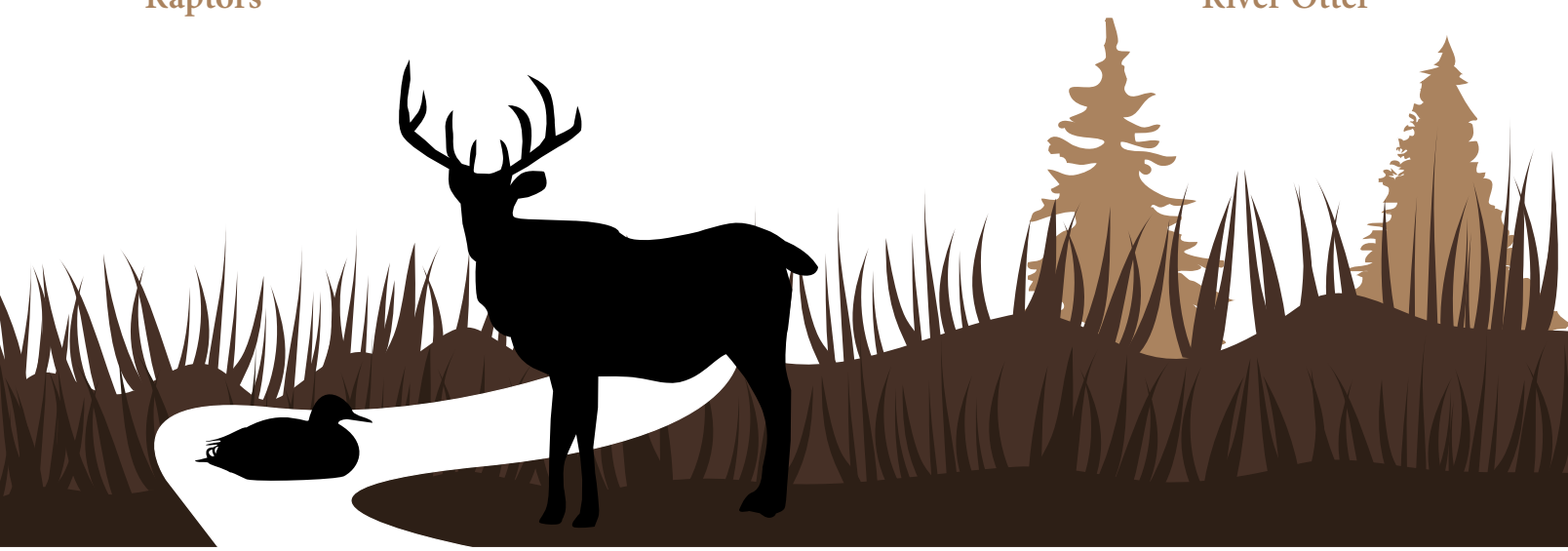
For more information on riparian and forest management refer to the North Dakota Forestry Best Management Plan (BMP) Manual, available on the ND Forest Service website at ***www.ndsu.edu/ndfs.***

WILDLIFE Birds & Mamals

Rivers and the adjacent riparian areas provide habitat for many species of wildlife. Riparian areas make up less than one percent of the total landscape in the Western United States, but they provide critical habitat for 90% of the wildlife found here. A riparian area provides safe travel corridors, enabling species to move from one habitat type to another, and, if the riparian area is wide enough, it will provide food and shelter for various wildlife species, especially woodland songbirds.

As people move closer to rivers, wildlife habitat becomes fragmented with houses, outbuildings, and roads; therefore, understanding the interaction between people and wildlife will help reduce the potential conflicts. Most of the time wildlife is nice to have around, but, at times, some species may become a nuisance. Any species can become habituated because of close and frequent contact with people, and some species may become a nuisance, especially when people provide them with food. When songbirds, squirrels, deer, raccoons, turkeys, and other species get used to a feeder for their primary food source, they may become a nuisance or may even become a health hazard. To avoid or minimize the problem of nuisance wildlife, avoid feeding or planting vegetation that will provide food. To avoid conflicts with wildlife, a protective fence around gardens is recommended.

- Songbirds
- Turkeys
- Waterfowl
- Raptors
- White-tailed Deer
- Squirrels
- Raccoon
- Woodchucks
- Beaver
- Mink
- Skunk
- Muskrats
- Fisher
- River Otter



BIRDS

Songbirds

Riparian areas are important to wide array of songbirds. If the riparian area is wide enough, you will have the opportunity to host songbirds that depend on a forest habitat for survival. Species such as Rose-breasted grosbeaks, Black-capped chickadees, and nuthatches depend on forest habitats. Other species, such as Yellow Warblers and various sparrow species, utilize the edges of the woodland for their habitat.

Figure 39. A photograph of a Blue Jay, courtesy of The Audubon Society, 2012.

Though providing feed for wildlife is unadvisable, if a riparian landowner wants to provide feed for songbirds, the proper food and type of feeder are important. Though songbirds are not usually a nuisance, bird feeders may attract turkeys, deer, squirrels, and raccoons, and often these species become a nuisance for a homeowner. Black oil sunflower seed is the best all around bird food because it attracts the most desirable birds, such as nuthatches, cardinals, goldfinches, Pine grosbeaks, Evening grosbeaks, chickadees, Blue Jays, and Grackles. Nyger seed, often incorrectly referred to as thistle, is popular with Finches and Redpolls. Whole corn and cracked corn will attract larger birds like doves, Wood ducks, and Mallard ducks. Deer and turkeys are also attracted to corn that will fall to the ground below the feeders. Suet is a mixture of animal fat and seed, usually millet, and not only attracts nuthatches and woodpeckers, but also will attract squirrels. If suet is used as a food source for songbirds, the homeowner should consider squirrel proof suet holders. Millet is inexpensive and will attract Black-eyed juncos, Towhees, and the Common-house sparrow. The homeowner should be aware that songbirds might inadvertently fly into glass windows and doors. Most of the time, the bird will recover, but sometimes a collision with a window is fatal. Window decals and other scare devices usually work to keep birds from flying into a homeowner's window.

Turkeys

Riparian corridors provide excellent habitat for wild turkeys. The turkey population will thrive when the corridor is wide enough to provide adequate nesting cover, winter cover, and food. In addition, large trees provide safe roosting sites. The diet of turkeys includes slugs, insects, nuts, berries, dandelions, birdseed below feeders, and garden plants. Turkeys will eat the shoots of young plants, including the shoots of flowers and vegetables, and they will eat most garden plants including tomatoes, berries, and apples. If there is a patch of open ground, turkeys will scratch the site for a regular dust bath. They pose little danger, but their droppings on lawns, driveways, and sidewalks can be a nuisance. Turkeys are attracted to sunflower seeds and corn.

Figure 40. A photo of turkeys by Martin Belan, Ohio 2012.

Waterfowl

Many species of central flyway ducks utilize streams and rivers for habitat in North Dakota, especially during the spring and fall migrations. Rivers with a tree component provide Wood duck habitat. In the duck family, Wood ducks are unusual because they nest in the cavities of large trees near water. Constructed boxes will give Wood ducks a place to nest because they will replace tree cavities that have been lost because of the removal of dead trees. River systems that do not have a woodland component will provide habitat for many other duck species common to the North Dakota. Maintaining a vigorous stand of herbaceous cover adjacent to the riparian area can provide adequate nesting sites for ducks. The narrow riparian corridors along some streams are not adequate nesting areas because predators easily find these waterfowl nests, a wider riparian zone along the river will increase the nesting success.

Figure 41. A photograph of a Wood duck, courtesy of The Audubon Society, 2012.

Figure 42. This is a photo of a Wood duck nesting box, courtesy of The Audubon Society, 2012.

Raptors

Woodland riparian zones provide excellent habitat for many species of raptors, also known as birds of prey. Red-tailed hawks, Sharp-shinned hawks, Eastern Screech owls, and Great Horned owls rely on riparian forests for their primary habitat. Raptors have sharp, hooked beaks that are used for tearing meat. They also have good eyesight and strong talons on their feet for hunting. Eagles, hawks, and owls can be seen perched on large trees and poles surveying riparian areas for fish and small mammals.

Figure 43. A photo of a Barred owl, courtesy of Matt Pierce, 2011.

There are nine different species of owls that reside in North Dakota. Species commonly found along riparian areas include; the Eastern Screech owl (7-10 inches long), Great Horned owl (18-25 inches long), and the Long Eared owl (13-16 inches long). The Barred owl (17-24 inches long) is found in riparian forests and is often quite vocal. As with most bird families, other species of owls may be seen during seasonal migrations. Because owls are nocturnal birds, they are mostly seen and heard at night.

The Peregrine falcon has adapted well to habitats in the city and will nest on tall city buildings. Fargo has a nesting pair of Peregrines that can be seen flying or perching along the riverfront looking for prey. Peregrine falcons have been seen catching common pigeons in mid air. More information about the Peregrines in Fargo can be found at *http://www.fargofalcons.net/.*

Figure 44. A photo of a Peregrine falcon, courtesy of The Illinois Raptor Center, 2012.

Many species of hawks are also found near riverfronts and in local parks. Hawks will eat other birds and may be seen preying on a bird in a birdfeeder. Songbirds that have been preyed upon will soon learn that a hawk is in the neighborhood and will temporarily stop using a feeder until the hawk leaves.

Figure 45. A photo of a Red-tailed hawk, courtesy of The Illinois Raptor Center, 2012.

MAMMALS

Other than songbirds, mammals utilize riparian habitats more than any other wildlife species. Most mammals will not only tolerate human fragmentation of the river and associated riparian ecosystem, but some species will flourish because of the fragmentation. Species, such as White-tailed deer, will take advantage of the increased food sources in gardens and young trees.

White-Tailed Deer

White-tailed deer often seek refuge in urban riparian areas and will often congregate in these areas during the winter months. Deer are a nuisance when they eat flowers, garden plants, or browse on apple trees. They also can become traffic hazards on city streets when they wander from shelter of the river to find food. When their riverfront haunts are flooded, they will leave the river habitat. Some cities have started special hunts to reduce the deer population. While some homeowners enjoy seeing deer, other homeowners do not appreciate them hanging around. Good practices for homeowners that will keep deer away from residential neighborhoods include using plants that deer do not like and avoiding providing food. The installation of a high fence or an electric fence will also keep deer away from areas that need to be protected. Deterrent practices, such as leaving radios on, spreading dog hair or human hair on the ground, and hanging soap in trees usually are short-lived successes in deterring urban deer.

Figure 46. A photo of a White-tailed doe and fawn, courtesy of the U.S. Fish and Wildlife Service, 2012.

Figure 47. A photo of a common Eastern Gray squirrel, courtesy of The National Park Service, 2012.

Squirrels

Three species of squirrels are found in North Dakota. The Eastern Gray squirrel is the most common squirrel found in riparian areas. Fox squirrels, the somewhat larger cousins of the Gray squirrel, are also common in rivers' woody habitats. The Gray squirrel's smaller cousin, the Red squirrel, is the most aggressive of the three and can often be seen chasing the larger Gray squirrel and Fox squirrel. Squirrels will chew their way into birdfeeders, birdhouses, garages, and attics seeking food or shelter.

The best defense for a homeowner is to squirrel proof all openings. The best way to keep squirrels away from your feeders is to use less desirable bird feed, such as safflower, because safflower will attract finches, mourning doves and other birds but won't attract squirrels. A homeowner may also want to try feeding squirrels something they like, such as sunflower seeds, in an easily accessible area that is away from other bird feeders.

Figure 48. A photo of a Red squirrel, courtesy of The National Park Service, 2012.

Figure 49. A photo of a Fox squirrel, courtesy of The National Park Service, 2012.

Raccoon

The common raccoon is a nocturnal mammal and is plentiful along the rivers in North Dakota. Raccoons are intelligent, opportunistic feeders that take advantage of garden produce and pet food dishes. They may appear to be cute and harmless, but they are fierce fighters, capable of inflicting harm on large dogs and other pets. Raccoons may also carry a roundworm that is spread by their droppings; the roundworm is dangerous to both pets and humans. Motion detector lights, overturned garbage cans, tracks around an outdoor grill, and droppings are often the only evidence that raccoons have been around a property. Homeowners can discourage visits from raccoons by taking pet food containers inside during the night. Fencing a garden rarely works, because raccoons are good climbers, and it is also difficult to raccoon-proof a birdfeeder. It's best to call the local animal control officer to have raccoons removed if they become a nuisance.

Figure 50. A photo of a raccoon, courtesy of the Wisconsin DNR, 2012.

Woodchucks

Woodchucks are cat-sized, brown rodents and wintertime hibernators; they are often active during the day, even though they live underground. Their burrows can be up to five feet deep and 30 feet long. Woodchucks will raid gardens and flowerbeds, searching for food, and, like raccoons, woodchucks are often viewed as cute, but they are vicious fighters. Live trapping and removal is the preferred method of abating a woodchuck nuisance.

Figure 51. A photo of a woodchuck, courtesy of The National Park Service, 2012.

Beaver

The American beaver is a large, brown rodent weighing up to 60 pounds and is second only to humans with an ability to change their habitat. Beavers are usually associated with above water lodges constructed of branches, logs, and mud. But in large rivers, such as the Red, the beaver lives in riverbank homes burrowed into the bank with either an underwater access or a visible access along the bank. For this reason, river beavers have often been referred to as "bank beavers." The beaver is mostly nocturnal and can swim underwater for up to 15 minutes. Beaver damage to riverbank trees can be prevented by installing woven wire fence around the base of the trees, which will discourage the beaver from chewing the trees.

Figure 52. A photo of a beaver (left), courtesy of The National Park Service, 2012, and a riverbank beaver den (right), courtesy of the Cass County Soil Conservation District, 2012.

Mink

The mink is a close relative of the skunk and has smelly anal glands to prove it. Mink will mark their territory with their scent when they are hunting, although the smell is not as overpowering as the skunk's smell. Mink often inhabit hollow logs or muskrat or beaver burrows in a riverbank. Mink rarely become pests; however, they will kill birds or other small pets if they are kept in an outside cage. The mink is a nocturnal mammal and will typically shy away from human activity.

Figure 53. A photo of a mink, courtesy of The National Park Service, 2012.

Skunk

The striped skunk does not hibernate but will sleep in underground winter dens during the coldest weather periods. A nocturnal mammal, the skunk is a known carrier of the rabies virus; people should be suspicious of a rabies infection if a skunk is viewed during the day. A rabid skunk will also act confused and disoriented.

To discourage skunks and woodchucks from burrowing under garages and storage sheds one should place rocks or bricks that extend six to twelve inches from the foundation along the ground. If a skunk is spotted in a neighborhood during daylight hours, contact the local animal control officer.

Figure 54. A photograph of a skunk, courtesy of the Minnesota DNR, 2012.

Muskrat

The common muskrat is often seen swimming in larger rivers, such as the Missouri River and the Red River; they have a rat-like tail that gives the muskrat its name. It is one of the more common river animals, and it rarely becomes a pest. It can be a carrier of Giardiasis, an intestinal parasite that is popularly known as beaver fever.

There are two other mammals that rely on river habitat and are making a comeback in North Dakota, primarily in the northeastern part of the state. Fishers, according to scientists, were considered gone from the state more than a century ago, while River otters were found years ago in all the major streams, but never in great numbers. Both animals are considered furbearers in North Dakota and are currently protected with a closed season.

Figure 55. A photo of the common muskrat, courtesy of Karl Kreiger, Missouri River, 2012.

Fisher

During the last decade, Fishers have made a remarkable comeback in North Dakota. The habitat Fishers are using isn't classic for the species, yet they seem to be making the best of what is available. They are found along river drainages because that's where much of the forest habitat in North Dakota is found. Fishers are about the size of a small fox, with long bodies and bushy tails. The fur is dark brown to nearly black, and is white-tipped over much of the body, giving fishers a grizzled appearance. They are at home on the ground and in trees, feeding on small mammals, birds, and carrion. It's one of few predators that feed on porcupines, attacking the head to avoid the quills. Fishers are solitary animals, except during breeding season, which takes places in late March or April.

Figure 56. A photo of a Fisher, courtesy of The National Park Service, 2010.

River Otter

River otters have a long and cylindrical body, similar to weasels and mink. The tail of a River otter is long and muscular, and it makes up one-third its body length. Their legs are short and muscular, with webbed toes. River otters have fur that is dark brown above and lighter below, with a gray or silvery cast on the throat. They are active year-round and River otters live in a variety of water habitats. Their diet consists mainly of fish, but they also feed on crayfish and mussels. They are social animals and form family groups consisting of an adult female and her young. Intelligent and playful, river otters will slide, wrestle, chase their tails, and play with sticks or captured prey.

Figure 57. A photo of a River otter, courtesy of The National Park Service, 2010.

Other mammals commonly found near rivers include bats, red foxes, moose, bears, and an occasional coyote. Maintaining river ecosystems and riparian areas will provide a much-needed habitat for many species of wildlife, and river riparian areas are used by almost all wildlife species in North Dakota. Riparian areas provide year round habitat, travel corridors, food, cover, and water for many wildlife species. As people continue to develop near rivers, the habitat for wildlife becomes patchy and can lead to conflicts. Understanding the interaction between people and wildlife will help reduce these conflicts.

Tips for Living with Wildlife

- **Do not encourage nuisance wildlife into a yard by offering food or shelter.**
- **Keep a safe distance from all wildlife, especially wildlife species that are potentially harmful.**
- **Contact the local animal control officer to remove nuisance animals.**

FLOODING

Natural floods are caused by excessive amounts of precipitation, especially if the precipitation falls in a short time, or by the rapid melting of a large snow pack. According to the Ecological Society of America, the average cost of damages from floods is more than four billion dollars in the United States every year. For communities located near rivers, a flood forecast is important in order to properly prepare for a flood. Flood forecasting is accomplished by the combined efforts of several agencies, but the primary two agencies that forecast floods are the National Oceanic and Atmospheric Administration (NOAA), an agency with the National Weather Service, and the United States Geological Survey (USGS). NOAA predicts weather events that may influence the occurrence and significance of future floods, while USGS monitors the stage or depth levels and the discharge or flow of rivers in the United States, which are used to forecast the flood crest.

USGS science for a changing world

USGS.gov

NOAA.gov

The size of a flood is defined by the potential frequency of a given flood. After analyzing the factors in a watershed that influence a flood, forecasters can estimate the severity of a flood. For example, if there is a 10% chance of a given flood, or one chance out of ten, then the severity of that flood would be classified as a "10-year flood". A one chance out of 100, or a 1% chance, of a flood occurring is considered a "100-year flood"; and one chance out of 500, or .2% chance, of a flood occurring is considered a "500-year flood." Under this system, the larger the interval would indicate a larger flood event.

Factors Affecting the Occurrence and Severity of Floods

- **The saturation of the soil from the previous fall's precipitation.**
- **The snow fall amount during the winter months.**
- **The amount of water in the snowpack.**
- **The rate at which the snow melts in the spring.**
- **The gradient slope of the river valley.**
- **The occurrence of ice jams.**
- **The amount of additional precipitation received during the spring melt.**
- **The location of roads, bridges, and levees.**
- **The amount of development in a floodplain.**

It is important to recognize that floodplains are a part of the river ecosystem. River channels have the capacity to carry a one-year to two-year flood event, after which water from the river will enter the flood plain. Floodplains are relatively flat because the river channel has moved laterally across the floodplain over time. Evidence of the lateral movement can be seen on aerial photographs as meander scrolls, or scars, that are left on the land.

The deposition of sediment on the inside bank of the meander, also known as the point bar, will build the floodplain over time as the meanders slowly shape the river valley. The meander belt, known as the outside extent of the meanders, is a good indication of the width of the floodplain. The illustration to the right, from Theodore Endreny of the State University of New York, shows the pattern of a typical meander belt.

It is important to maintain the connection between the stream channel and floodplain. Allowing the stream to overflow once the river channel is full, energy begins to dissipate and the likelihood of major flooding downstream is reduced. Floods are inevitable, but there are ways to reduce the damage to property and the risk to human lives.

In areas where streams have a low slope gradient, like the Red River Valley, floodwaters can extend far beyond the immediate floodplain during a large flood event. This aerial view of the Red River flood south of Fargo in 2001 shows the devastation from a large flood. Though flooding is often considered a disaster for communities and for agricultural areas, inundating the floodplain with sediment and nutrients is a benefit for the natural ecosystem.

Figure 58. This illustration depicts the various landforms and deposits of a floodplain and the topographic features created by meandering streams. Adapted from "Stream Corridor Restoration: Principles, Processes, and Practices" by the FISRWG, Oct. 1998.

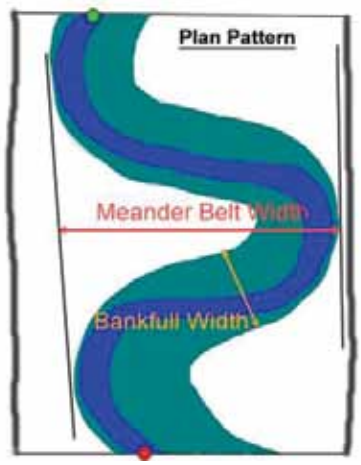


Figure 59. This illustration depicts meander belt width and bankfull width. Adapted from "Fluvial Geomorphology Module" by Endreny, 2003.

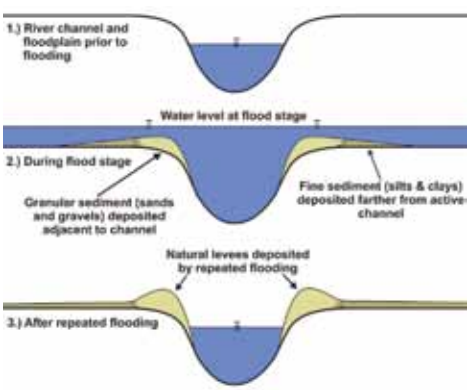


Figure 60. This diagram depicts the process of natural levee formation. Adapted from "Should I Trust that Levee?" by Rogers, 2007.

Figure 61. A photo of flooding south of Fargo, courtesy of North Dakota State University, 2001.

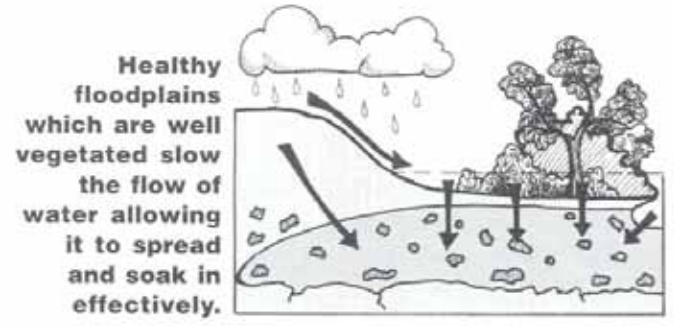


Figure 62. A diagram depicting flooding over healthy floodplains with proper vegetation, in "Caring for the Green Zone – Third Edition" by Cows and Fish, 2003.

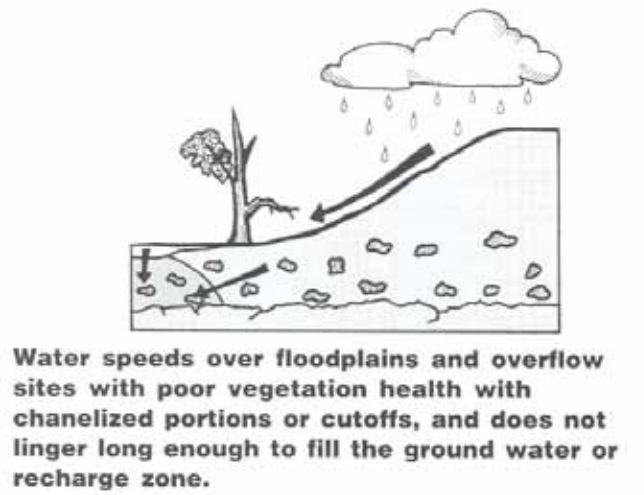


Figure 63. A diagram depicting flooding over unhealthy floodplains due to the lack of proper vegetation, in "Caring for the Green Zone – Third Edition" by Cows and Fish, 2003.

The elimination of permanent structures in areas known to flood is the best way to prevent damages from flooding. Many governments have ordinances that regulate where permanent structures may be placed. The ordinances are determined by the elevation of the structure and the distance of the structure from the riverbank. Setback ordinances may also exist, intended to control issues related to riverbank slumping. People planning to build a new structure should check with the local building authority.

A healthy riparian area will slow down the flow of the water in a river, allow the water to soak into the ground more effectively, and reduce riverbank erosion during flood events. Therefore, it is important to maintain, improve, or replace riparian areas to an adequate width to buffer the effects from flooding.

Figure 64. A photo depicting the natural floodplain encroached by structures, courtesy of the Cass County Soil Conservation District, 1997.

Benefits from Flooding

- **Flooding provides woody debris for fish species.**
- **Flooding fills wetland areas with water for fish spawning.**
- **Flooding gives native plant species a competitive edge over invasive species and provides a seedbed for natural tree regeneration.**
- **Flooding forms natural levees along rivers.**

DAMS

Dams and impoundments are built for a number of reasons. Dams can minimize the effects from flooding, capture and produce electrical energy, and create recreational areas. However, dams can also have negative impacts on a river ecosystem.

The water occurring above a dam is different from the water below a dam in a number of ways. In a natural state the water in rivers and streams is sediment rich, but once it reaches a reservoir the velocity decreases and the sediment settles to the bottom. The reservoir will begin to fill with sediment and over time the sediment accumulation will alter the ability of the dam to function. The water downstream of the dam will lack sediment causing the river's equilibrium to be out of balance. The river will then attempt to restore its equilibrium and will likely erode the bottom and sides of a channel in order to regain the sediment it needs, and the process will cause the river to become incised. An incised river often times loses the connection to the floodplain and as a result loses the ability to release energy during high flow events. In areas where the soils are weak, such as silt and clay soils, an increase in riverbank slumping is the result.

Dams affect the water quality and the organisms that live in the river. Water released from dams will have a different temperature and velocity than a river in a natural state.

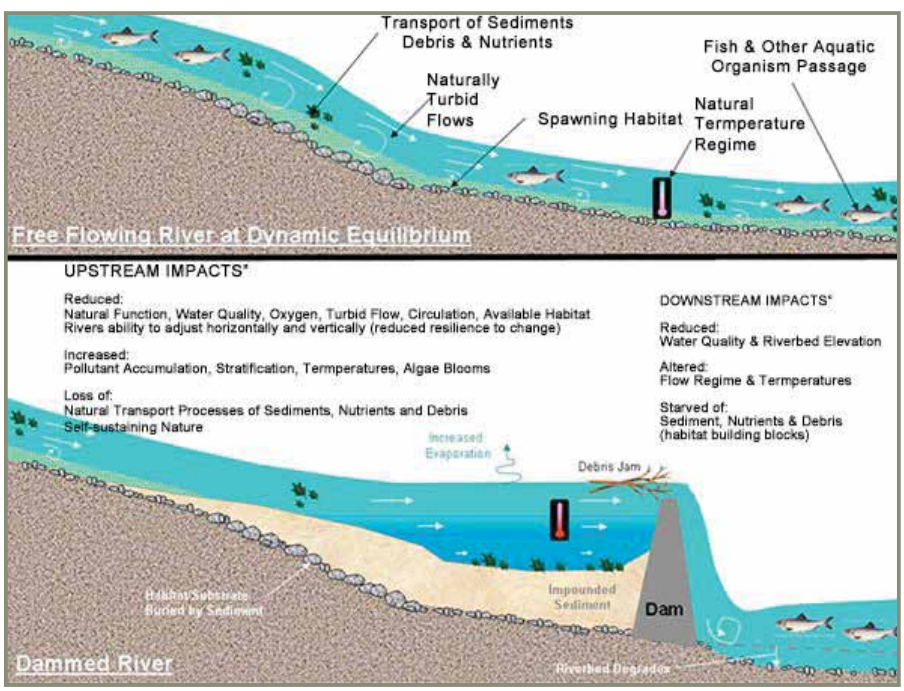


Figure 65. This is a photo of the Maple River Dam in Cass County, courtesy of the Cass County Soil Conservation District, 2012.

Figure 66. An illustration depicting the effects of a dam on the equilibrium of a river from Vermont Surface Water Management Strategy, 2003.

Depending on how water is released from a dam, it may have a decreased level of dissolved oxygen as well. The distribution and quantity of aquatic species will change when the temperature and velocity of the water changes because many aquatic organisms require specific ranges in temperature and levels of oxygen.

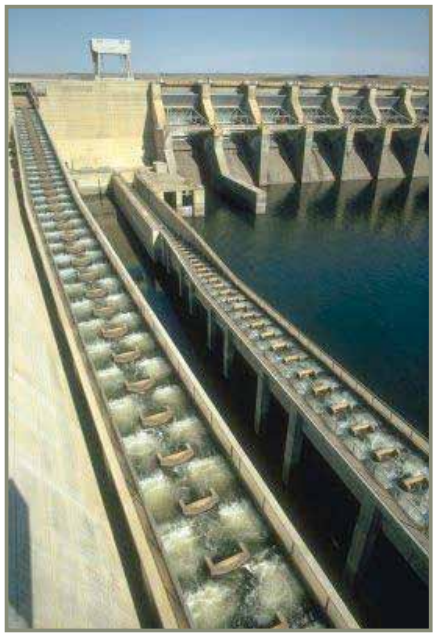


Figure 67. This photo shows fish ladders along a dam, courtesy of the U.S. Army Corp of Engineers, 2012.

Dams prevent fish and other aquatic species from moving upstream. Some fish species migrate upstream to spawn, and preventing this movement can cause a decline in the population of fish species and may even lead to an extinction of some fish species. The loss of native fish may also cause the decrease in the population of native mussels, resulting in poorer water quality and less diversity of bottom dwelling organisms. To reduce the negative effects to fish populations caused by dams, engineers may include fish ladders in their designs, as shown in Figure 67.

Figure 68. This is the sign posted at many dams warning of the "drowning machine" currents in "The Drowning Machine" by Elverum and Smalley and the MN DNR, 2008.

Dams may exhibit a phenomenon known as hydraulic rollers below the dam, often referred to as a drowning machine because they can trap humans, animals, and debris. In the past, over 20 people have died because of the hydraulic rollers located below the dams in Fargo. The dams in Fargo have since been altered with rocks to provide for fish passage and to reduce the dangers from a hydraulic roller.

GLOSSARY of Terms

Aggradation – Occurs when the level of the channel bottom increases as sediments carried in the water are dropped.

Bankfull – The stage at which water in the river will begin to spill onto the floodplain.

Cut bank – The outside bank of a river meander where scouring and erosion occurs.

Degradation – Occurs when the bottom of the stream channel lowers (downcutting), as sediment is removed from the bottom of the channel and carried away with the flowing water. Degradation is also referred to as incision.

Deposition – Occurs when a river drops its sediment load, as its speed or volume decreases. The load, which it carries, is deposited. The heavier material is deposited first, and the finer material carried further.

Discharge – The amount of water flowing past a given point over a specific period of time, usually measured in cubic feet per second (ft3/sec.).

Erosion – The process by which materials are removed from a position on the surface of the land and transported to a different location, via wind or water. Rates of erosion can vary depending on bank composition and moisture content, bank vegetation, and speed of flow.

Eutrophication – The process by which a body of water acquires a high concentration of nutrients, especially phosphates and nitrates, which cause excessive growth of algae. Eutrophication is a natural aging process for a water body, but human activity greatly speeds it up.

Floodplain – The flat area of land bordering the river channel that is frequently subject to flooding during high water levels.

Thalweg – The deepest part of the stream channel.

Meander – A curve or bend in a sinuous river pattern.

Point Bar – The inside bend of a river meander, where deposition occurs.

Oxbow Lake – A river meander that has been cut off from the main channel.

Riparian Area – The area (also called riparian zone or riparian buffer) where the land and river meet.

Sediment – The natural material, such as rock and sand that is broken down into smaller particles by proceees of weathering, and through erosion is transported by air or water and later deposited.

Scour – The erosion of soil by water.

Scroll Bars – Scars on the land from previous meanders of a stream.

Sinuosity – The level of curvature in the river bends.

Stage – Depth measured in feet above some reference elevation.

Toe Bank or "The Toe" – The bottom of the bank where the river transitions into the channel bottom.

CONTACTS for Organizations Statewide

ND Association of Counties http://www.ndaco.org/counties/	Use the map on this site to find your local county departments. Click on a county, and the county website will come up.		
ND Association of Rural Electric Cooperatives http://www.ndarec.com/	PO Box 727 3201 Nygren Drive NW Mandan, ND 58554	Toll free: 800-234-0518 Phone: 701-663-6501	Fax: 701-663-3745
ND Association of Telecommunication Cooperatives http://www.ndatc.com	3201 Nygren Drive NW P.O. Box 1144 Mandan, ND 58554	Phone: 701-663-1099	Fax: 701-663-0707
ND Association of Township Officers http://www.ndtoa.com	Executive Secretary E-Mail ndtoa@polarcomm.com	Phone: 701-655-3513	
ND Association of Soil Conservation Districts http://www.ndascd.org/	3310 University Drive Bismarck, ND 58504	Phone: 701-223-8518	Fax: 701-223-1291
ND Department of Agriculture http://www.agdepartment.com	600 East Boulevard Ave. Dept. 602 Bismarck, ND 58505- 0020	Phone: 701-328-2231	Fax: 701-328-4567
ND Department of Health http://www.health.state.nd.us	918 East Divide Avenue Bismarck, ND 58501-1947	Phone: 701-328-5150	Fax: 701-328-5200
North Dakota State University Extension Service http://www.ext.nodak.edu/	Morrill Hall 315, PO Box 5437 Fargo, ND 58105-5437	Phone: 701-231-8944	Fax: 701-231-8520
ND Forest Service http://www.ndsu.edu/ndfs	Molberg Center, 307 1st. St. East, Bottineau, ND 58318-1100	Phone: 701- 228-5422	Fax: 701-228-5448
ND Game & Fish Dept. http://gf.nd.gov/ Game Warden (Your Local Contact)	100 N. Bismarck Expressway Bismarck, ND 58501-5095	Phone: 701-328-6300	Fax: 701-328-6352
ND NRCS State Office Natural Resources Conservation Service http://www.nd.nrcs.usda.gov	220 East Rosser Avenue Federal Building, Room 270 Bismarck, ND 58501	Phone: 701-530-2000	Fax: 701-530-2109
ND One-Call Locator www.ndonecall.com		Phone 1-800-795-0555	Or dial 811
ND Parks & Recreation http://www.parkrec.nd.gov/	1600 E. Century Ave., Ste 3, Bismarck, ND 58503-0649	Phone: 701-328-5357	Fax: 701-328-5363
ND Water Commission http://www.sws.state.nd.us	ND State Water Commission 900 E. Blvd. Ave, Dept. 770 Bismarck, ND 58505-0850	Phone: 701-328-2750	Fax: 701-328-3696
Official Portal for ND State Government http://www.nd.gov/home/htm	This website will list all the state agencies, and their websites.		
RC&D State Office Resource Conservation & Development www.ndrcd.org	220 East Rosser Avenue P.O. Box 1458 Bismarck, ND 58502-1458	Phone: 701-530-2110 TDD: 701-530-2114	
Red River Riparian Project Red River Regional Council http://www.ndhealth.gov/rrbrp/	516 Cooper Ave Ste 101 Grafton, ND 58237	Phone: 701-352-3550	Fax: 701-352-3015
River Keepers http://www.riverkeepers.org	325 7th Street South, Suite 201 Fargo, ND 58103-1846	Phone: 701-235-2895	
U. S. Fish and Wildlife Service North Dakota Field Office http://www.fws.gov/	3425 Miriam Avenue Bismarck, ND 58501-7926	Phone: 701- 50-4481	Fax: 701-355-8513
U.S. Geological Survey North Dakota Water Resource Center http://nd.water.usgs.gov/	821 East Interstate Ave Bismarck, ND 58503	Phone: 701-250-7400	Fax: 701-250-7429

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PUBLICATION SUMMARY

Living With A River .... a handbook about North Dakota river ecosystems. The many photos and illustrations along with commentary will help people understand rivers and how they function. Perhaps a better understanding of the powerful and dynamic forces of rivers will encourage people to respect their destructive nature and at the same time admire their natural beauty. Perhaps then, people will be able to live with rivers.