Minnesota River Basin
TRENDS

Dear Reader

This is the first Minnesota River Trends document. The purpose of this report is to provide a broad overview of trends related to the state of the Minnesota River. It is meant to be easy-to-read overview that summarizes some of the major demographic, land use, water quality, biological and recreational trends in the Minnesota River Basin over the past 10 to 100 years depending on data availability. In a few cases, where an analysis of change over time was not possible, the report includes information on current conditions.

The indicators included in the following report were prioritized by a group of agency representatives and citizens with the hopes of providing some clues of broader ecosystem health across the Minnesota River Basin. What you will discover in this document is a mixed story—research shows some indicators improving, some declining, some static. We hope that this document will provide insight into this dynamic, complex and varied river basin.

The river has been studied extensively and is managed by a number of different agencies and organizations for a variety of purposes. The report draws data from researchers across many diverse fields. Thanks to our many project cooperators (see list on back page). If you want to learn more, a rich resource list used to develop this report is available online http://mrbdc.mnsu.edu/mnbasin/trends

As you will see, many actions and projects have been put in place to try to understand and improve the water quality across the basin. Cleaning up the rivers and lakes in the basin is a complex and challenging endeavor that will take time. Some progress has been made and much still needs to be accomplished. Many diverse groups across the basin are working together to improve ecosystem health for future generations.

We welcome your feedback, please contact us (see below).

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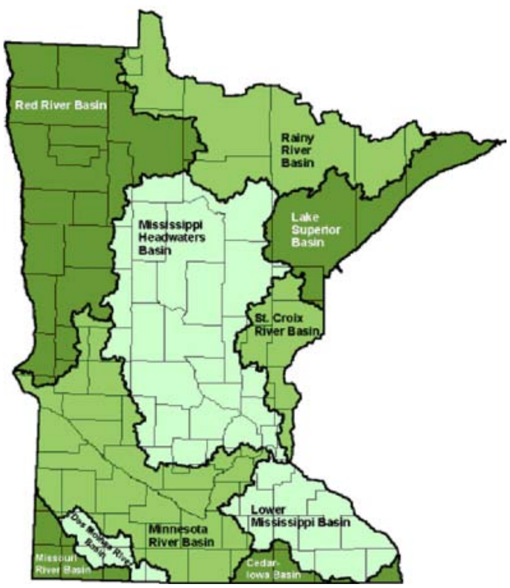
The Minnesota River Watershed Alliance

A Resource of Local, State, and National Importance

Basin Overview

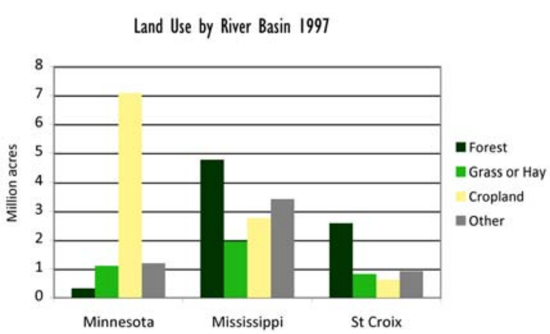
The Minnesota River Basin drains nearly 20 percent of Minnesota as well as portions of South Dakota, Iowa and North Dakota. The basin encompasses roughly 15,000 square miles and contains all or parts of 38 counties in Minnesota. The Minnesota River flows 335 miles from its source in Big Stone Lake on the Minnesota/South Dakota border to its confluence with the Mississippi at Fort Snelling near St. Paul. The river flows through some of the richest agricultural land in the state.

Minnesota's River Basins



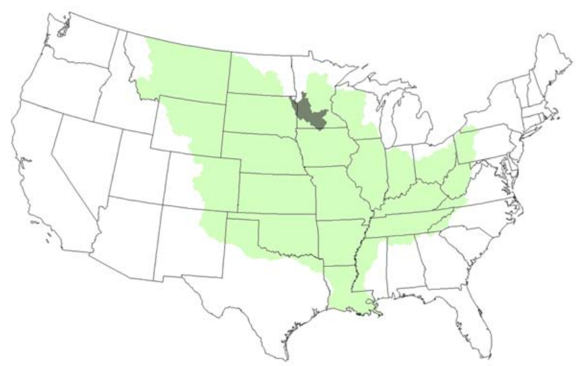
Map Source: Minnesota Planning
http://www.gda.state.mn.us/maps/RiverBasins.gif

One of ten major river basins in Minnesota, the Minnesota River Basin occupies a large portion of Southern Minnesota.



Minnesota - Mississippi River

The Minnesota River is the state's largest tributary to the Mississippi River. When the Minnesota River flows into the Mississippi River, its flow doubles. The Minnesota River impacts downstream waters by carrying sediment and nutrients into the Mississippi River and ultimately the Gulf of Mexico.



History Section

The following section provides an overview of how the landscape has changed in the Minnesota River Basin over time. Researchers have pieced together what the landscape looked like before it was drained, plowed, logged and developed by Euro-American settlers in the mid-1800s.

Pre Euro-Settlement Conditions

Prairie, buffalo, wild rice, "lakes of grass" historically dominated the Minnesota River Basin

Early explorers accounts and paintings provide glimpses of what the landscape resembled before widespread European settlement. Many explorers wrote descriptions about the rich flora and fauna and Native Americans inhabiting the Minnesota River Valley in the 1700s and 1800s. They described a landscape covered in tall grass, wetlands, shallow lakes and forested areas with numerous American Indian tribes living along the Minnesota River.

"Early explorers . . .described many features we can no longer see, including huge prairie fires roaring across the landscape, abundant prairie chickens and "prairie dogs", flocks of whooping cranes feeding in wet meadows, and beds of wild rice in many lakes and Minnesota River backwaters. Bison and elk were vanishing by then. Though the explorers encountered many difficult circumstances, they often described the landscape with awe" (MCBS, 2007).

Seth Eastman painting of the Prairie at the mouth of the Minnesota River from the 1830s or 1840s

Prairie, River Valley, Lakes of Grass

[Proceeding westwardly from new Ulm], "the plateau that opens here presents neither hills nor woods. It is a high, grand, and beautiful prairie. The view to the south seems limitless, the verdure losing itself far away in the azure of the sky. The spectacle is full of grandeur because of its simplicity that contrasts agreeably with the varied and picturesque countryside the valley of the Minnesota presented to us during the last five miles. Our route continues in generally a westerly direction, leaving on the right and on the left a great number of swampy ponds or more often depressions in the soil that form in the springtime some many "lakes of grass" as the Indians say. The route is lovely and firm. The prairie plants, tall, plentiful, and varied, indicate that the soil is good." – Joesph Nicollet, 1838

Seth Eastman painting of the Minnesota River Valley from the 1830s or 1840s (near Fort Snelling)

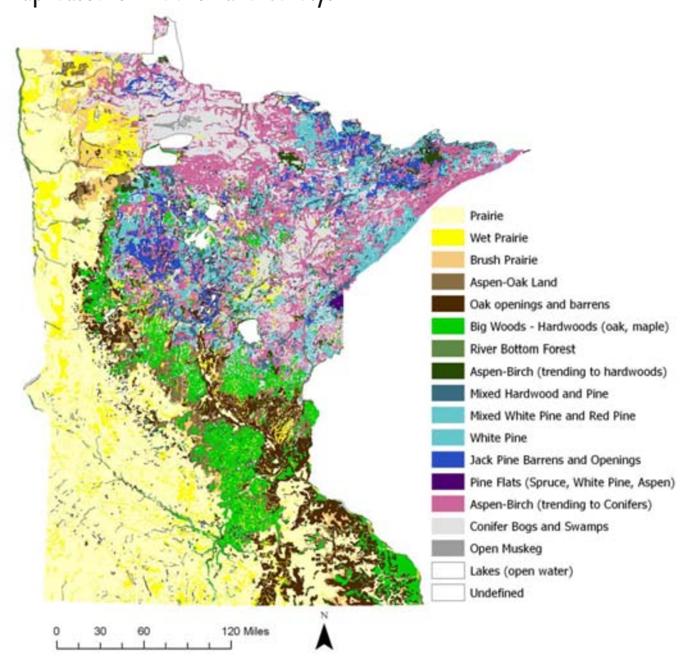
Otters, Buffalo, Wild Rice, Ducks

"We paddled away at the rate of four or five miles an hour ... when the otters were seen swimming amongst the zizania. Milor said that buffaloes were killed here about five years ago, but that he thinks the animals have been so persecuted that they will never return. The musk-rats were already at work building their conical houses on the marshy grounds, with mud and straw of the wild rice, against the approach of winter. As we advanced through these low rice-grounds, clouds of wild ducks rose on the wing, and we killed them at our leisure from the canoe." – George Featherstonhaugh, 1835

Wild Rice

"A most delightful country, abounding with all the necessaries of life that grow spontaneously . . . Wild rice grows here in great abundance; and every part is filled with trees bending under their loads of fruit, such as plums, grapes, and apples." – Jonathan Carver, 1766

Minnesota's Original Vegetation
Map based on Public Land Surveys



The best information for mapping Minnesota's pre-European settlement vegetation was gathered by the Public Land Surveys from 1853-1870. Adapted from Marschner, F.J. 1974.

Prairies

Prairies that once dominated the landscape—less than one percent remains

Prior to Euro-American settlement, more than 18 million acres of prairie covered Minnesota. Our prairie lands were part of the largest ecosystem in North America, which stretched from Canada to Mexico and from the Rockies to Indiana. A wealth of diverse species, habitats and cultures thrived here. At the time of Euro-American settlement, upland prairie spread across most of the land south and west of Mankato. Historically, fires burned annually over large areas of Southern Minnesota limiting freqency and location of trees (MCBS, 2007). The prairie landscape of the Midwest was one of our nation's most diverse terrestrial ecosystems. Over 900 species of plants have been recorded on remaining prairies in Minnesota, with up to 300 or more species per individual prairie remnant. Almost half of Minnesota's rare species are prairie plants and animals (DNR, 2008).


C. Henderson

Rough blazingstar

Today less than one percent of the original expanse of Minnesota native prairie remains.

Conversion of Prairie to Cropland

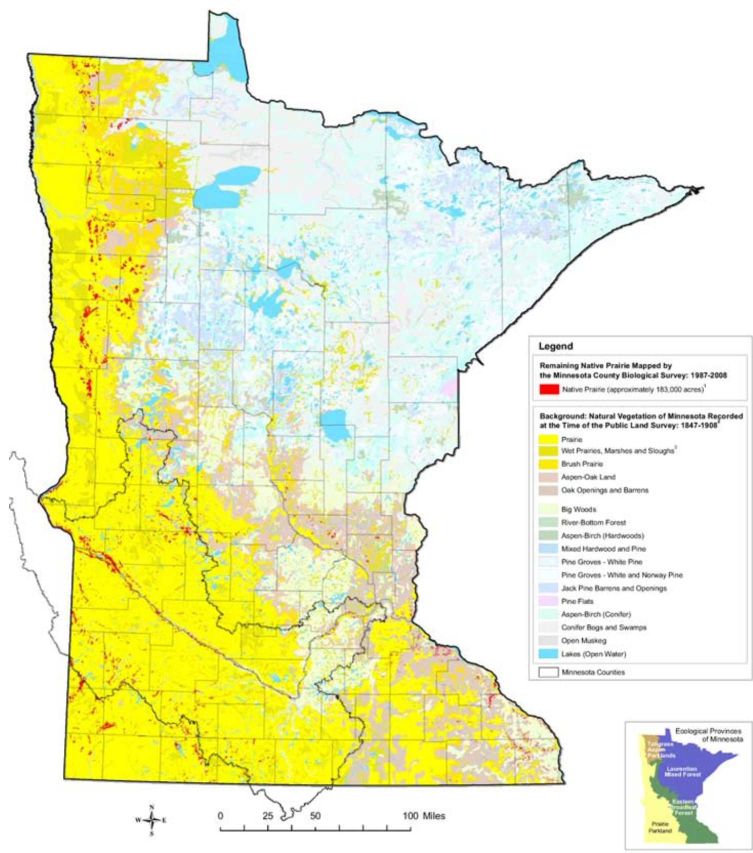
Statewide, today only 180,000-200,000 acres of prairie remain compared to the 18 million acres of prairie prior to Euro-American settlement, In the Minnesota River Prairie subsection of the state (see map left area in yellow) DNR researchers estimated landscape change from 1890s to 1990s that shows the conversion from prairie to cropland (DNR, 2006).

	1890s	1990s
Prairie	77.6%	0.0%
Wetland Non-forest	13.0%	1.9%
Grassland		9.0%
Cropland		83.0%

Source: DNR, 2006

"Prairie is rolling or gently undulating and bearing most everywhere an unusually healthy growth of grasses are auspicious [for settlers]...except for the entire want of timber." —Public land surveyor David Watson describing the prairies in Swede Prairie Township of Yellow Medicine County in 1867 (MCBS, 2007).

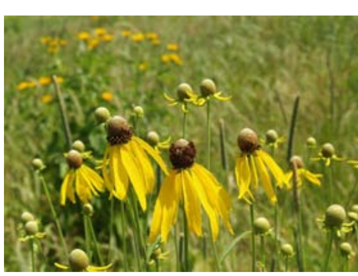
Minnesota's Remaining Prairie
100 Years After the Public Land Survey



The map above shows the small amount of native prairie that remains statewide. It depicts current native prairies documented by the DNR's Minnesota County Biological Survey from 1987-2008 (shown in red), in comparson with the prairie vegetation recorded during the Public Land Survey from 1847-1908 (shown in yellow and tan). Less than 1 percent of the prairies recorded in Minnesota during the Public Land Survey remain (MCBS, 2009).


Scott Kudelka

Big Bluestem


Scott Kudelka

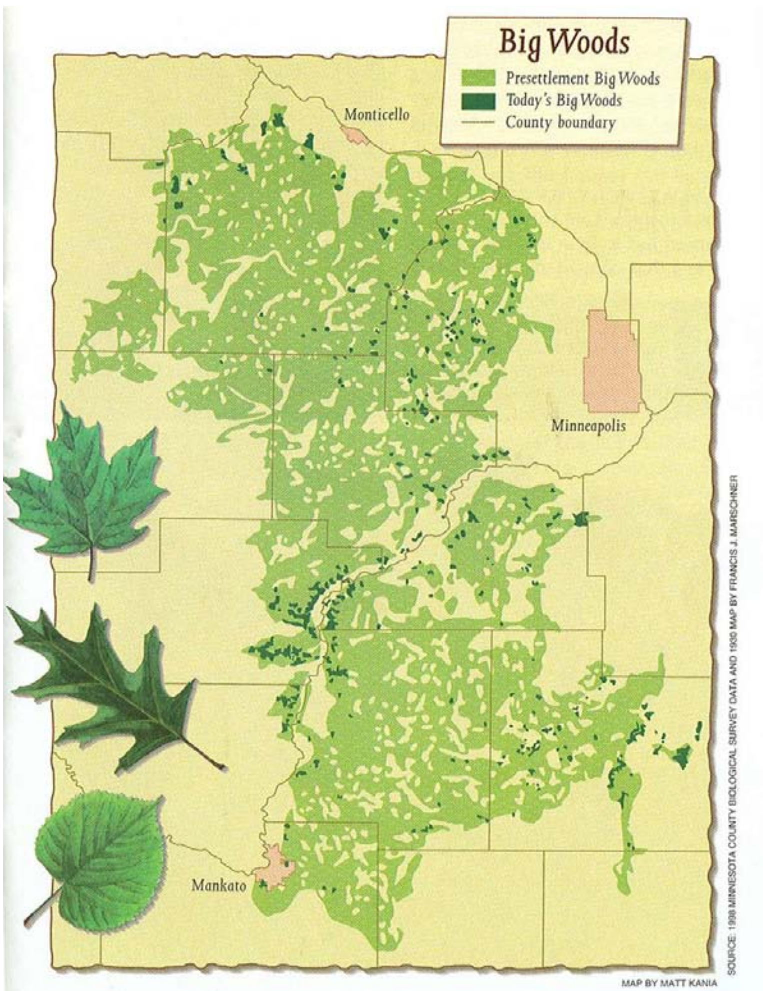
Yellow coneflower

Big Woods

Big woods whittled down—only two percent remain


Jay R. West

At one time, a 2,000 to 3,000-square mile forest extended from the Mankato area north to Monticello. Filled with elm, sugar maple, basswood and oak, this deciduous forest stood in contrast to the surrounding immense prairie-wetland landscape. French explorers in the 17th Century called it bois fort or bois grand, later translated as the "Big Woods" by English-speaking settlers. Today, less than 2 percent of the original "Big Woods" remains after Euro-American settlers began to clear the forest to establish farms, plant crops and build cities (Crosby, 2002). Surveyor N. H. Winchell wrote about the Big Woods of southern Minnesota in 1875, "The existence of this great spur of timber, shooting so far south from the boundary line separating the southern prairies from the northern forests, and its successful resistance against the fires that formerly must have raged annually on both sides, is a phenomenon in the natural history of the State that challenges the scrutiny of all observers" (DNR, 1998).



The Big Woods came into existence 300 to 400 years ago when the climate of North American began to cool. This change in temperatures resulted in fewer fires that were beneficial to the brush land, prairie and oak savannas dominating southern and western Minnesota. The area of the Big Woods didn't burn as frequently because it was made up of rivers, and a rolling, lake-dotted terrain. Over the next few hundred years, this dense, tall forest of elm, sugar maple, basswood and oak covered the landscape.

Big Woods Timeline

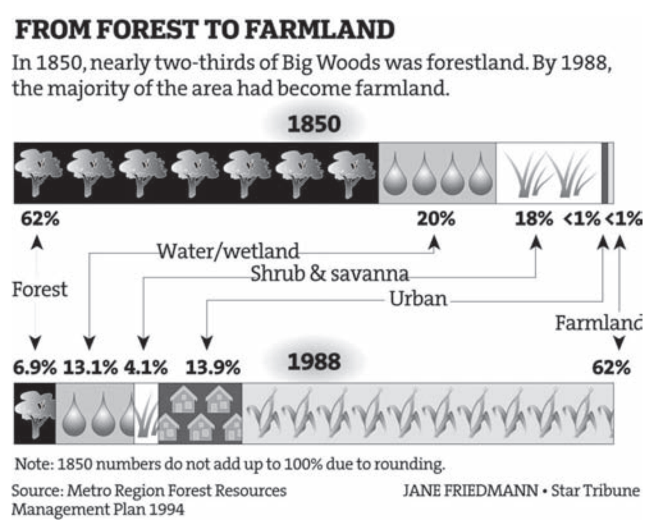
1850s: Euro-American settlers began to clear the 2,000 plus square mile Big Woods by converting it into cropland.

1930s: Only a patchwork of 40 to 80-acre woodlots of the Big Woods remained (DNR, 1998).

Today: Approximately 2 percent of the original Big Woods is left—a quarter of that is protected in parks or preserves—the rest in private hands.


Minnesota Historical Society

People living in the Big Woods collected maple syrup, dug ginseng root, cut the trees for building and fuel among other uses.



Land Drainage

Dramatic increase in a managed drainage system


BNC Water Quality Board

Swan Lake


BNC Water Quality Board

In the beginning tiling was mostly done by hand using a spade to lay concrete or clay tile.

Wetlands historically dotted the Minnesota River Basin, with wetland complexes once common on the prairie-dominated landscape. Early explorer's accounts described the prairie and wetlands extending as far as the eye could see. Settlers moved in and drained the wetlands to farm the rich, productive farmland. Today, almost 90 percent of prairie wetlands have been lost.


BNC Water Quality Board

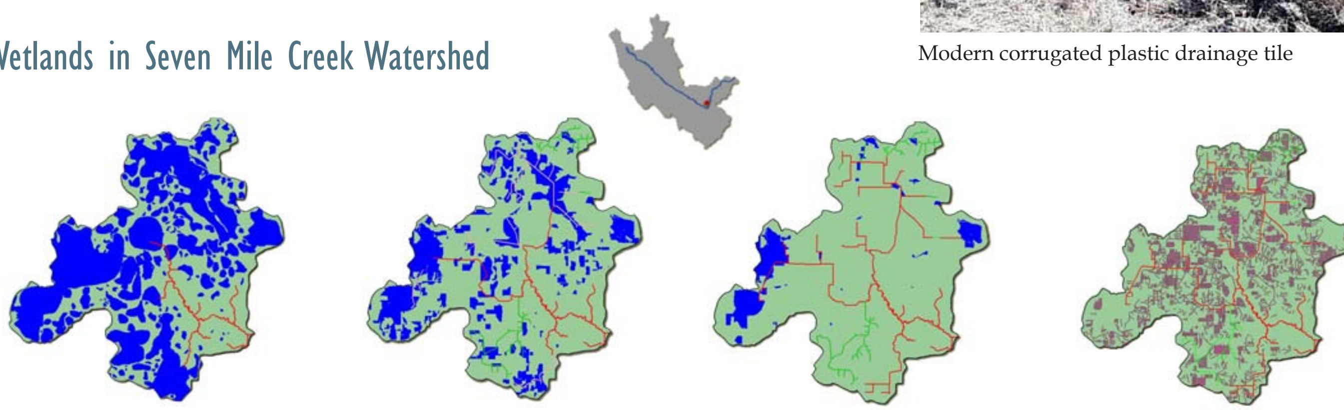
Changes in Hydrology

The movement of water in the Minnesota River Basin before Euro-American settlement would have been different from today. The landscape consisted of a vast prairie pockmarked with wetlands. The prairie sod allowed rapid infiltration of precipitation. The wetlands were connected to subsurface hydrology. The flows of the rivers were likely sustained by ground water inputs for most of the year. As prairies were plowed precipitation followed surface runoff paths into lakes and wetlands which were ditched and drained in many areas to remove water rapidly from the landscape thus enabling large-scale farming (MPCA, 1997).


Kevin Kuehner

Modern corrugated plastic drainage tile

Wetlands in Seven Mile Creek Watershed



Seven Mile Creek is a minor watershed in the Lower Minnesota River Basin (near St. Peter, Minnesota). These maps are based on a study that examined historic aerial photos over time. The study found that the Seven Mile Creek watershed lost about 88 percent of wetlands from 1854 to 2003 (shown in blue). This correlates with other scientific research that estimate 90 percent of the wetlands have been lost in this part of Minnesota. The 2003 map highlights the engineered system. The purple lines illustrate private drainage tile and the red indicate county drainage ditches and natural channels. Researchers estimate that more than 5.3 million feet of tile have been laid in the Seven Mile Creek Watershed. In this relatively small watershed (36.8 square miles) the study calculated approximately 640 miles of artificial drainage systems.

The River Today

Today, the river is a reflection of its landscape. The wetlands have largely been drained and the prairies and big woods have been converted to row crop agriculture. With that conversion comes changes in water quality and impacts to plants and animals that live throughout the basin. Some progress has been made cleaning up the river and there are some encouraging signs. The job of cleaning up the river is much more challenging and complicated than many people realize.


Metropolitan Council Environmental Services

Twin Cities Metropolitan Area

Water quality

Many lakes, rivers and streams in the basin known to exceed water quality standards and are listed as "Impaired Waters" by MPCA. For 2008, there are 336 impairments listed in the Minnesota River Basin. The river is polluted to the extent that swimming is not recommended and anglers are warned to limit their consumption of fish taken from the river. On the other hand, long term statistical trend studies are showing some improvements in water quality, particularly in total suspended solids and total phosphorus.

Chetomba Creek (6-6-05)


Hawk Creek Watershed Project

After heavy rain (6-7-05)

Partnerships - Improvements

Many organizations are involved in the Minnesota River clean-up. Counties and Soil and Water Conservation Districts develop and implement local Water Management Plans. Counties are responsible for feedlots, septic systems, and planning and zoning. The Minnesota River Board provides policy and basin-wide program support. This joint powers board was created in 1995 to promote water quality improvement and management across 37 counties with land that drain into the Minnesota River. The Minnesota River Basin is divided into 13 major watersheds and nearly every one of the major watersheds in the basin has a watershed project working to monitor and improve water quality. These projects partner with local, state, and federal government along with private groups and citizens. Agencies provide regulation, education, and incentives to improve the river. Academic institutions conduct research and provide information. Non-governmental and citizen organizations engage the general public, help popularize and communicate scientific information, and catalyze public debate about the river (MPCA, 2007). Many land restoration projects have been implemented and Best Management Practices (BMPs) are being applied across the basin. A conservation highlight for the basin was the Conservation Reserve Enhancement Program (CREP) where more than 100,000 acres were secured into permanent conservation easements. People are working together across the basin to improve the health of the ecosystem for future generations.


Friends of the Minnesota Valley

Citizens pitch in at the Friends of the Minnesota Valley Clean up Day


Scott Kudelka

Stakeholders from across the basin share ideas at the Minnesota River Summit


Scott Kudelka

Paddling the Minnesota River


MPCA

Walleye caught on Minnesota River near Carver Rapids

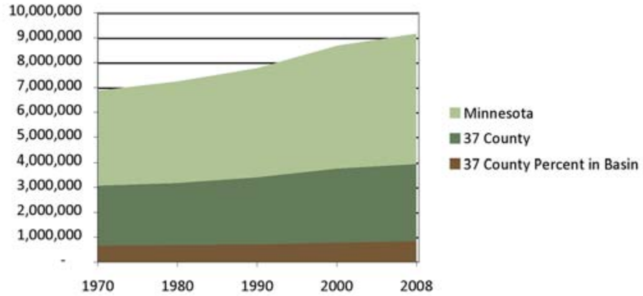
Recreation & Tourism

Increasingly citizens are realizing the recreational opportunities that the basin offers: fishing, boating and paddling rivers and lakes, visiting state parks and exploring this richly diverse landscape.

Population Trends

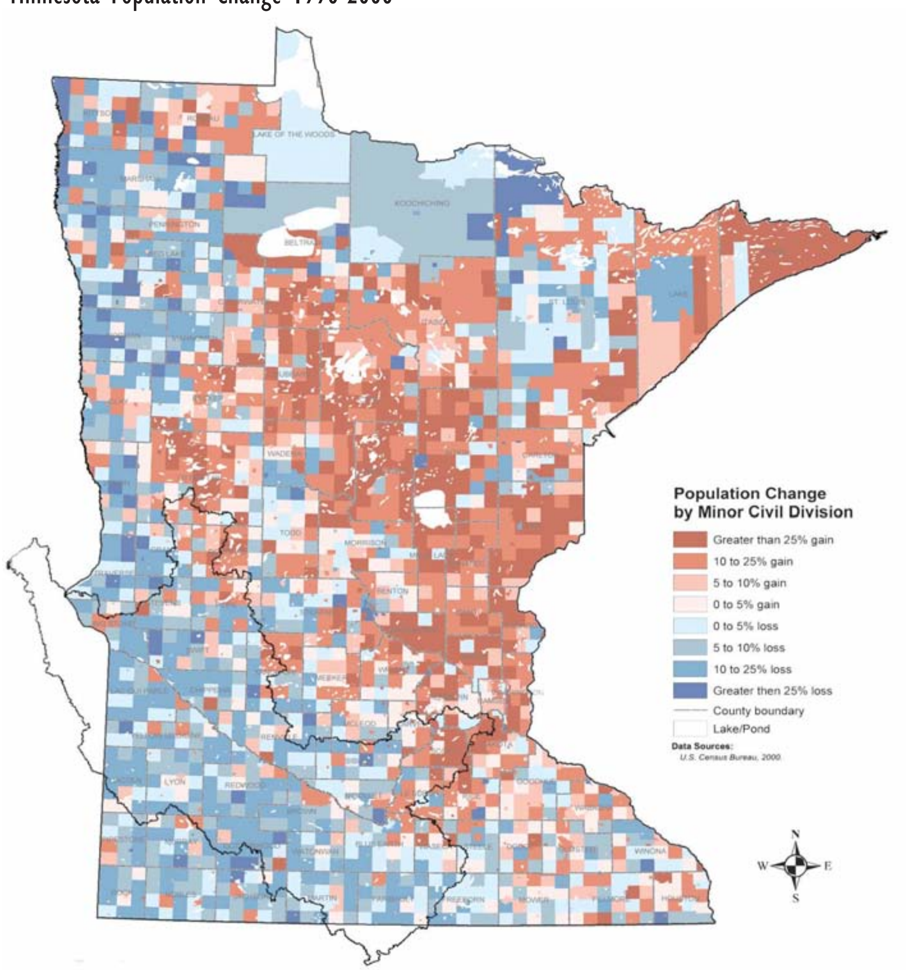
Urban areas on the rise—Rural areas declining

Minnesota & Minnesota River Basin Population 1970-2008



As the graph above shows, population growth has been more rapid across the state of Minnesota than within the 37 county Minnesota River Basin from 1970 to 2008. The Population Change map below illustrates the change in population between 1990-2000. The vast majority of the basin is in blue, indicating a decrease in population over the decade. The table at right underscores the overall pattern depicted on the map with metro-area counties Scott, Carver and Dakota illustrating significant increases in population while many south western counties show continuing population declines.

Minnesota Population Change 1990-2000



Map Source: Minnesota Planning

County Population Change 1990-2000

County	Percent Change
Scott	54.72
Carver	46.52
Dakota	29.31
Rice	15.21
Douglas	14.46
Otter Tail County	12.71
Stearns	12.10
Swift	11.49
Steele	9.60
Le Sueur	9.41
McLeod	8.95
Hennepin	8.11
Waseca	8.00
Sibley	6.89
Kandiyohi	6.30
Nicollet	6.04
Ramsey	5.20
Pope	4.57
Blue Earth	3.51
Lyon	2.57
Watonwan	1.66
Grant	0.69
Martin	-0.05
Murray	-0.05
Brown	-0.27
Chippewa	-1.06
Freeborn	-1.44
Redwood	-2.54
Renville	-2.94
Jackson	-3.50
Cottonwood	-4.15
Faribault	-4.46
Yellow Medicine	-5.17
Stevens	-5.46
Pipestone	-5.68
Lincoln	-6.69
Traverse	-7.37
Big Stone	-7.40
Lac qui Parle	-9.60

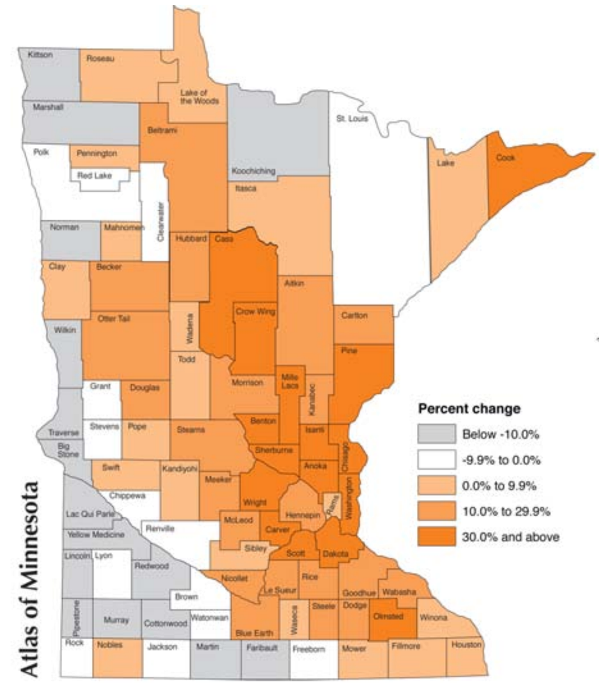
Urban

Population growth in the suburbs

The Minnesota Population Change map (at right) shows Minnesota's population change from 1990-2007. Over that time period, the state grew an estimated 822,500, from 4.4 million to 5.2 million, but that growth was not evenly spread throughout the state. Growth in the suburban counties that ring the Twin Cities (dark orange on the map indicates greater than 30% gain) stands out. Counties within 50 to 75 miles of the Twin Cities showed dramatic growth, especially Carver and Scott counties. Scott County, for example, has more than doubled from 1990-2005. On the other hand, smaller cities and townships across the southwestern portion of the state have been losing population. Population loss (grey and white) is shown across a large swath of the basin (Center for Rural Development and Policy, 2008).

In recent decades, the Minneapolis-St. Paul metropolitan area's growing economy has attracted new residents and stimulated urban growth. From 1990-2000, the population of the core seven counties — Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington — grew from 2.28 to 2.64 million (Yuan et al., 2005). Another study reported that from 1974 to 2000 the population of the seven-county metro area increased by 38 percent while the urban land area increased by 59 percent (EPA, 2003). This expansion of low-density suburbs into formerly rural areas have environmental impacts on air and water quality and loss of farmland and forests.

Minnesota Population Change 1990-2007



Source: Center for Rural Policy and Development, 2008

Urban Development & Impervious Surfaces

Remote sensing techniques enable researchers to show urban development by mapping changes in impervious surfaces. Impervious surfaces are those that water cannot infiltrate (rooftops, streets, highways, parking lots). The amount of impervious surface directly affects the amount of runoff to streams and lakes, and impacts the water quality of area lakes and streams. Metro area maps (below) show dramatic changes from 1986 to 1991. The seven-county metro area, the percentage of impervious area increased from 9 percent in 1986 to 13 percent in 2002. The greatest changes occurred in Anoka and Carver Counties, where the impervious surface area more than doubled (Manson et al., 2006). Beyond the metro area (maps below), urban development and increased impervious surfaces are concentrated in a few medium and small sized cities visible in pink on the maps below. Outside the Metro Area, only a few counties are registering growth rates comparable to the Twin Cities.

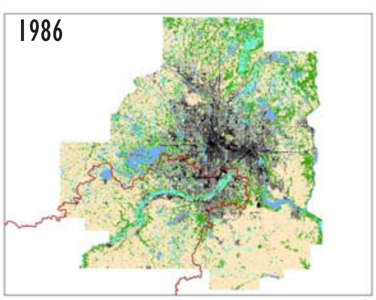
Metropolitan Design Center

Eden Prairie Housing Development and the Minnesota River

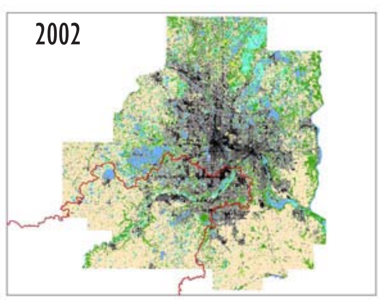
Metro Area Impervious Surface

Maps Courtesy of University of Minnesota's Remote Sensing and Geospatial Analysis Laboratory. Pink color denotes a higher degree of impervious surface area.

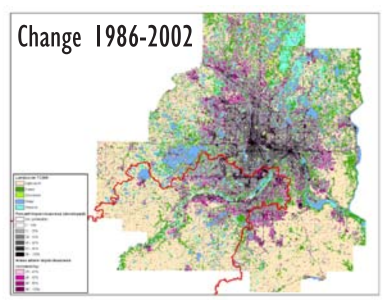
1986



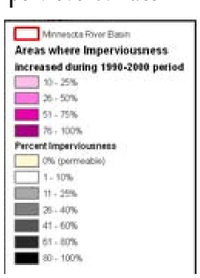
2002



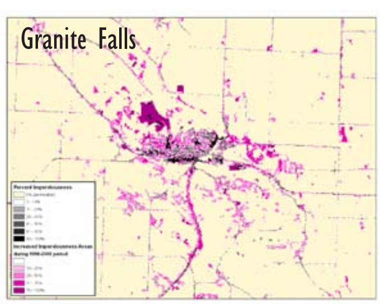
Change 1986-2002



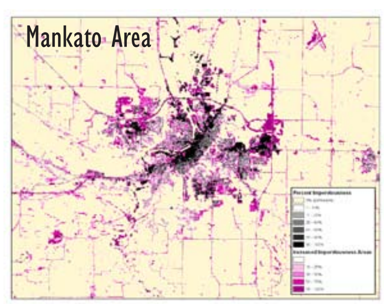
Outside Metro Area Impervious Surface Change 1990-2000



Granite Falls



Mankato Area



Rural
Southwestern Minnesota counties see an ongoing population decline

Historic Rural Demographic Trends

The population of many rural counties in southwestern Minnesota peaked in 1940 after the devastating Great Depression and the onset of World War II pushed many people to move for economic reasons. In addition, young men and women who served in the military and the war production effort were drawn to urban areas that offered higher wages and educational opportunities. For counties like Lac qui Parle, Lincoln and Yellow Medicine there has been a continuing decline since the 1940 census as their population grows older and fewer jobs are available for younger people.

According to the USDA Economic Research Center, per-capita incomes and high school graduation rates for rural areas lag behind urban centers, while poverty and unemployment numbers are higher. Rural areas have a harder time creating new businesses and jobs as "Minnesota shifts from a manufacturing-based economy to one that is more technological, global, service-oriented and knowledge-based," reports Minnesota Planning.

Outmigration of Young People

Fewer opportunities for employment, higher education and social amenities have been identified as the major reasons young people leave rural areas along with low wages and the lack of affordable housing. In the 1990s, 21 counties in Minnesota lost population, predominately in the west and south. This out-migration of young people has resulted in a "disproportionate and rising percentage of elderly people in these rural communities." Minnesota Planning expects this trend to continue.

Concentration of Elderly Residents

The greatest concentration of older residents is found in the southwestern part of the state. Traverse County has the highest percentage of elderly residents at 26.2 percent followed by Lincoln at 24.4 percent and Lac qui Parle at 23.2 percent, reports the Minnesota Demographic Center. A 2000 Census Portrait stated, "The largest concentrations of elderly people are rural areas that have experienced out-migration of young people, mirroring the same dynamic that occurs among many western states."

Population Projections

Over the next 20 to 30 years, rural counties in southwestern Minnesota are projected to continue losing population including Lac qui Parle, Lincoln and Yellow Medicine.

- Lac qui Parle is expected to see negative 9.6 percent growth rate from 2005 to 2015 and a 15 percent decrease from 2015 to 2035.
- Lincoln will see less of an impact with a negative 3.1 percent and 2.9 percent decrease, while
- Yellow Medicine has a projection of negative 5.4 percent growth rate and 9.0 percent decrease from 2015 to 2035 (Minnesota State Demographic Center, 2007).

Scott Kudelka

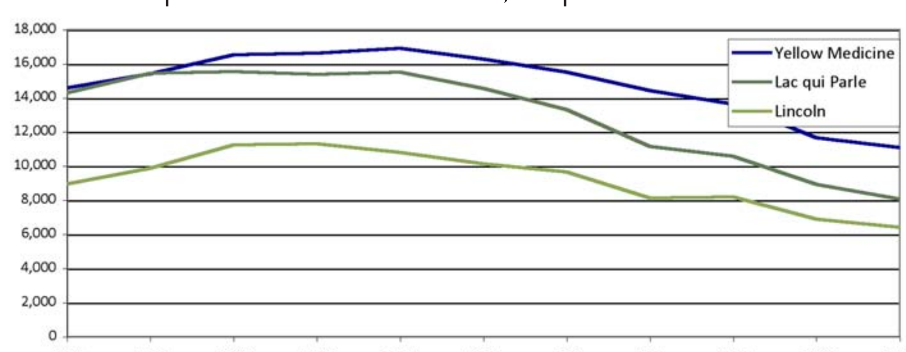
Downtown Dawson, Lac qui Parle county.

The abandoned farmstead is only a building site. Many of these abandoned farmsteads have been removed to be converted to cropland.

Dave Craigmile

Abandoned farm in Lac qui Parle county.

Population 1900-2000: Yellow Medicine, Lac qui Parle & Lincoln counties

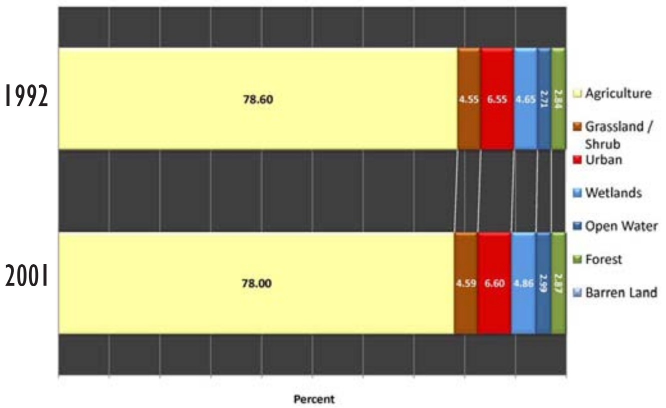


Farm Land Predominates

Agricultural production dominates basin land use

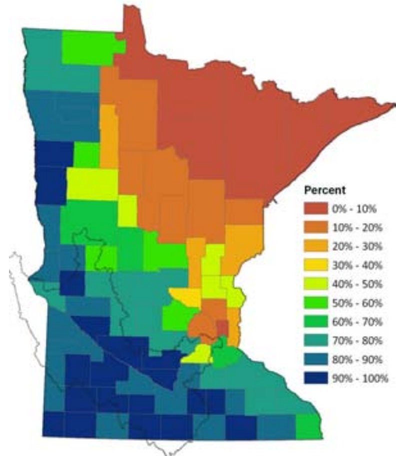
Ron Bolduan

Land Use Change in Basin 1992-2001



Source: Minnesota Agricultural Statistics

Land in Farms 2007



Source: Minnesota Agricultural Statistics

Land Use

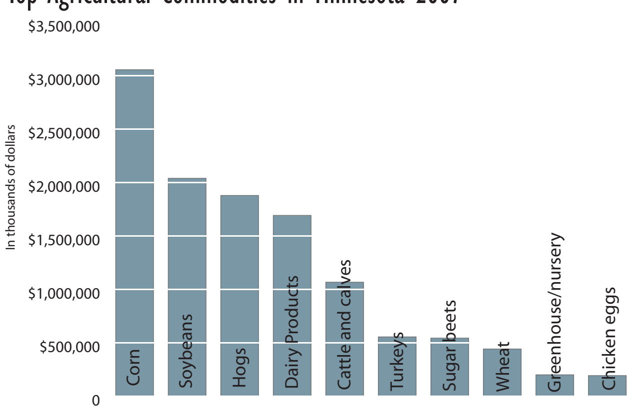
Today row crop agriculture is the predominant land use in the basin. The Minnesota River Basin consists of 10.85 million acres (9.5 million acres within Minnesota). In 1992, there were 8.52 million acres of agricultural land (78.6%). In 2001, there were 8.46 million acres of agricultural land (78%). Other land uses include grassland/shrub, urban, wetlands, open water, forest, and barren land. Notable changes in land use from 1992-2001 include a slight decrease in agricultural lands and an increase in wetlands, open water, and urban lands. The amount of land in crops remained relatively stable over the same time period.

The Minnesota River Basin is one of the most productive agricultural regions in the state. The basin stands out statewide as a region with a higher percentage of land in farms (see map above).

Craig Anderson, MDNR

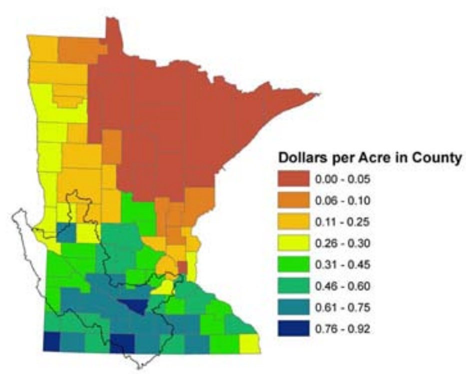
Remnant prairie and the Pomme de Terre River amidst an agricultural landscape

Top Agricultural Commodities in Minnesota 2007



According to the 2007 U.S. Census of Agriculture, Minnesota Farms generated $13.2 billion (market value) in agricultural products, with 53 percent in crops, vegetables, nursery crops and other related crops, and 47 percent in livestock, livestock products and poultry. Together these farms help Minnesota rank as the seventh top agricultural producing state in the nation. As the "Market Value" map at right shows, the Minnesota River Basin is a top-producing region.

Market Value of Agricultural Commodities 2007



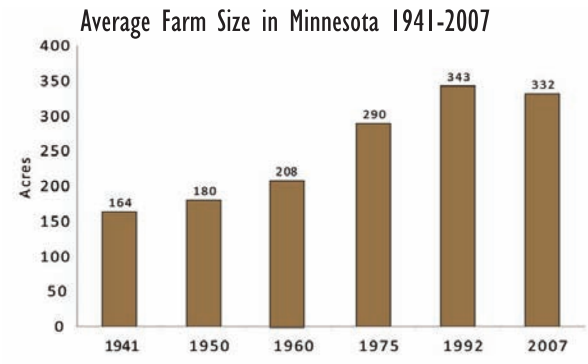
Farm Size and Number

Fewer and larger farms

Over the last two decades, there have been two distinct trends—a rapid decrease in the number of small farms and production concentrated in fewer farms with increased level of production. New technology have lead to significant changes in agriculture. Each producer now raises more crops and livestock than ever before. These changes have effected people directly involved in agriculture but also rural communities across the basin (EQB, 1999).

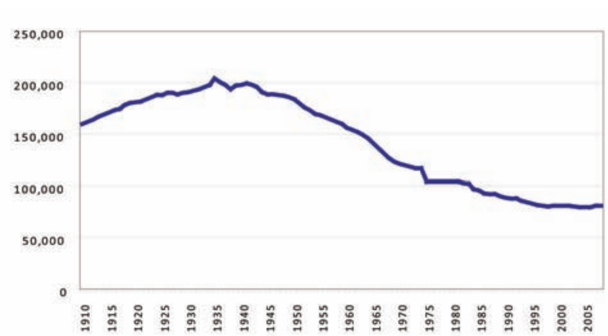
Scott Kudelka

Average Size of Farms Increasing



Number of Farms in Minnesota Decreasing

Number of Farms in Minnesota 1910-2006



In the Minnesota River Basin, farm size has increased while the number of farms has decreased over time (see graphs above). This has resulted in people leaving rural areas in some parts of the Minnesota River Basin (see demographics section).

Microtrend: Farmer's Markets

Scott Kudelka

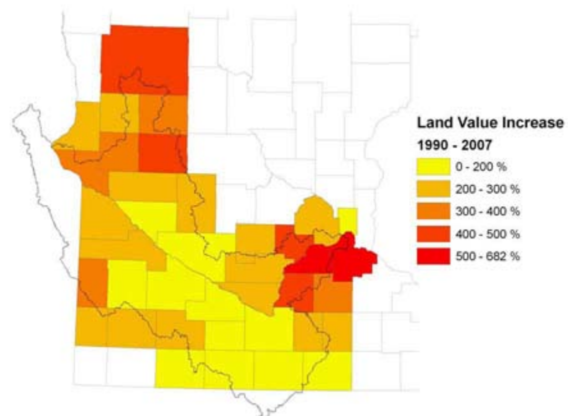
New Ulm Farmer's Market

In the last few years there has been an increase in the number of farmer's markets throughout the state. The number of farmer's markets in the Minnesota has tripled in the past five years with close to 130 operating in both rural communities and metro areas. In the Minnesota River Basin there are around 35 farmer's markets from Ortonville to the Twin Cities who offer their products directly to the consumer.

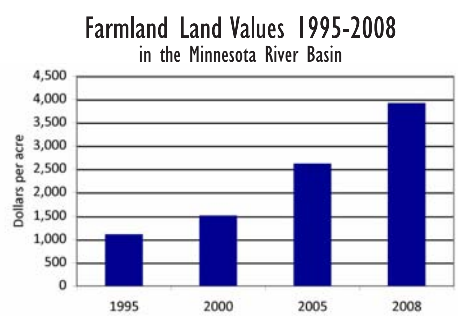
How many people does the average farmer feed?

Today, the average American farmer feeds 130 people. In 1960 a farmer fed just 26 people. In 1919, a farmer could feed his family and 12 others (NAWG, 2008).

Land Value Increasing



The map above illustrates the change in land values from 1990 to 2007 across the Minnesota River Basin. In recent years, demand for farmland for residential and commercial development has driven up values, as can be seen in the urban and suburban counties of the Twin Cities and the lake-rich counties in the north. The graph below shows the average farmland land values in the Minnesota River Basin. The average value for Minnesota farm land in 2008 was $3,923 per acre, compared to $2,619 in 2005 and $1,114 in 1995 (Minnesota Land Economics, 2009).

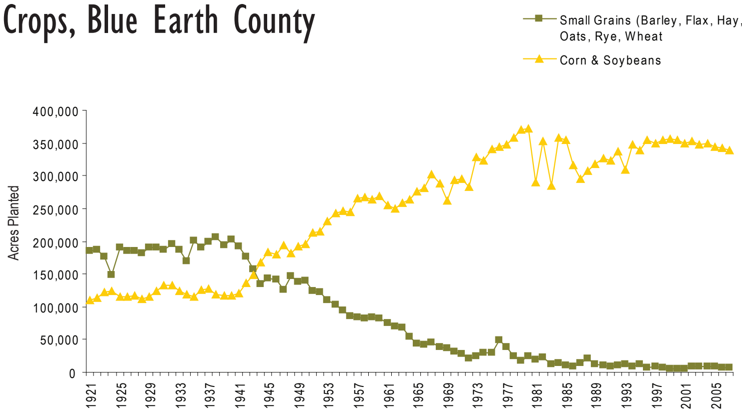


Source: UM Minnesota Land Economics

Crop Types & Farming Practices

Types of cops have changed over time—from mixed to predominantly corn and soybean

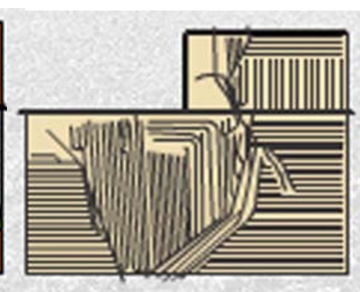
Crops, Blue Earth County



The types of crops grown throughout the Minnesota River Basin have changed over time from a diverse array of crops to predominantly corn and soybean. A farm-scale case study in Mapleton Township in Blue Earth County illustrates these changes over time (Burns, 1954). The graph at left shows the shift from small grains (barley, flax, hay, oats, wheat) to corn and soybeans that occurred in the 1940s. This post-WWII shift to corn and soybean dominance echoes the trend across the basin and the broader midwest US.

Types of Crops, Blue Earth County

1937
This 400-acre farm is on flat land with poorly drained soils. Diverse crops include oats, alfalfa, pasture, wild hay, barley, and corn. Note depressional sloughs or "potholes" dotting the landscape.



1948
The tile system was installed in 1948. It was estimated that 38,000 feet of tile were laid on this 400-acre farm.

1952
By 1952 soybeans and corn are planted on a larger portion of the farm along with pasture, peas, winter wheat, alfalfa, oats and flax.

2005
Aerial photos of the farm from the 1960s to present shows the farm predominantly in corn and soybean rotations.

www.mccormick-deering.com

BNC Water Quality Board

www.l.caseih.com

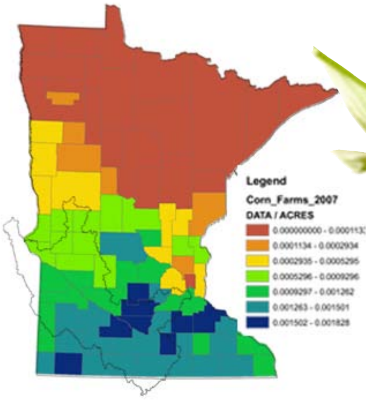
Minnesota Soybean

Minnesota Soybean

Corn & Soybeans

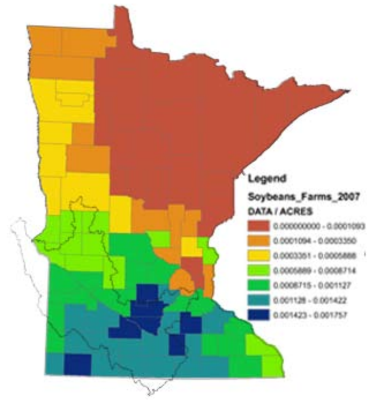
Corn and soybean crops predominate

Farms in Corn 2007



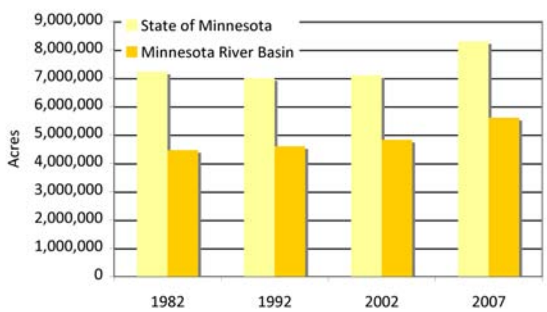
University of Minnesota Extension

Farms in Soybean 2007

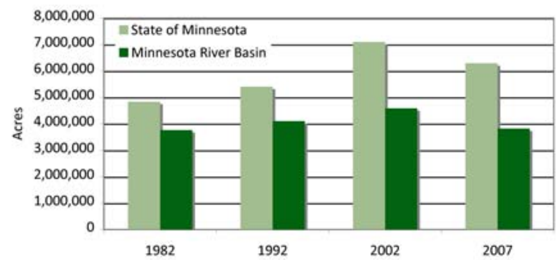


Minnesota Soybean

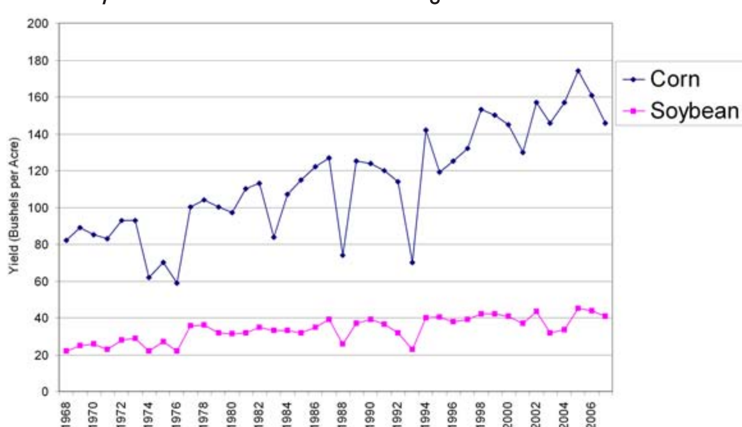
Corn Acres Harvested



Soybean Acres Harvested



Corn and Soybean Yields: Minnesota State Average 1968-2007



Corn Density and Yield

1920s 8,000 plants per acre
Yield: 20 bushels per acre

Late 1930s Hybrid seed comes on the market that is bred to produce thicker stalks and stronger root systems to stand better upright in a crowd and withstand mechanical harvesting.

1950s 12,000 plants per acre (LeBaron, 2008)
Yield: 70-80 bushels per acre

Today 30,000 plants per acre
Yield: 200+ bushels per acre (Pollan, 2006)

Corn Yields Show Dramatic Increases

The graph below illustrates the dramatic increase in corn yields from 1968-2007. According to University of Minnesota agronomist D.R. Hicks, increased corn yields are due to the combination of higher yielding hybrids, good weed control, good fertility programs, higher plant populations, earlier planting, and weather factors (Hicks, 2006).

Scott Kudelka

Minnesota Soybean

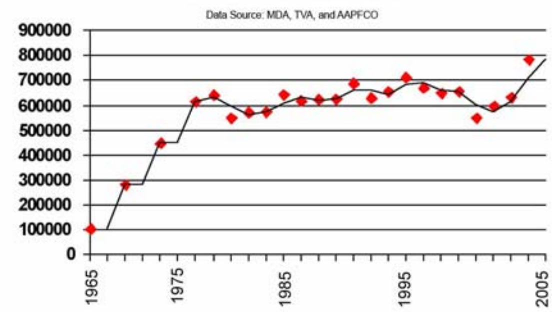
Fertilizers

MDA

Nitrogen

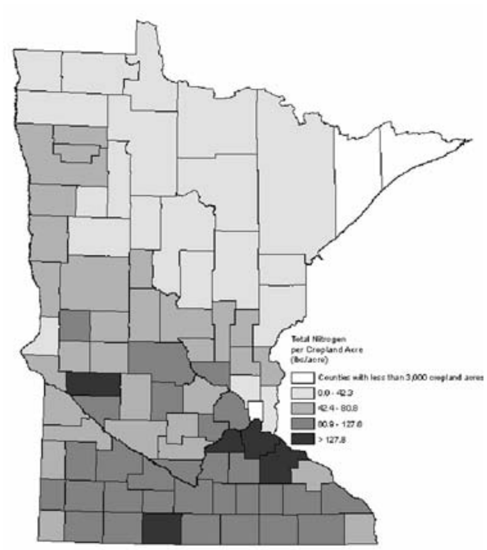
Post WWII there was an explosion of commercial fertilizer use across the US. The statewide fertilizer sales graph at right provides an indication of Nitrogen rates used by producers. Total annual Nitrogen sales in Minnesota during the same time period increased from 100,000 to 600,000 tons (Montgomery, 2008). This echoes the broader trend across the US as Nitrogen fertilizer usage rapidly increased from approximately 40 lb Nitrogen per acre from 1965 to 110 lb Nitrogen per acre in 1988 (Tennessee Valley Authority, 1988).

Commercial Nitrogen Fertilizer Sales Trends
in Minnesota 1965-2004



Source: Montgomery, DATE

Nitrogen Input Estimates



The map above depicts nitrogen input estimates based on 2002 Census data for county nitrogen fertilizer sales (point of sale), "fertilizer replacement" credits from manure and legume contributions. Inputs are averaged across all cropland acres within each county (Birr et al, 2008). The Minnesota River Basin stands out as a region with higher nitrogen inputs.

Did You Know?

At the end of World War II the federal government scrambled to find a use for the vast amounts of ammonium nitrate stockpiled from making explosives for the war effort. As a result, munitions plants were converted into chemical fertilizer plants for agricultural crops (Pollan, 2006).

Sources of Nitrogen

The primary sources of nitrogen in Minnesota's surface waters include: fertilizers, animal manure, municipal sewage wastes, agricultural and industrial wastes, atmospheric deposition, and dinitrogen fixation (as well as naturally occurring nitrogen) (Randall, Mulla, 2001). The transport of nitrate-N to surface waters can occur through base flow or subsurface drainage systems. The amount of drainage water leaving the landscape largely depends on climate and soil properties. Researchers frequently identify agriculture as a major contributor of nitrate-N to surface water. A common theme among numerous studies is that agricultural N remains a major component of total N export to rivers in the basin (Montgomery, 2002).

Farm Scale Study

A 2007 farm study in Seven Mile Creek Watershed can serve as an example of nitrogen use in the basin. Eighteen farms totalling 9,183 acres of farmland were inventoried for the study. Corn acres accounted for 99 percent of the nitrogen applied and 100 percent of the manure applications.

Field corn accounted for more than 92 percent of the pounds of commercial nitrogen (N) fertilizer applied on the farms studied. Nitrogen applications to corn averaged 157 pounds per acre (see graphic below). All field corn acreage received either commercial N fertilizer or manure. Field corn received most of the N with 99 percent of the total applied. Field corn yield goal for these farms averaged 182 bushels per acre (Bu/Ac) and were consistent with the five-year historical averages of 172 Bu/Ac (MDA, 2007).

Nitrogen Applied on Corn Acres
Average for Seven Mile Creek Watershed 2007

157 lbs of Nitrogen applied per acre	Commercial Nitrogen 125 lbs	82% Anhydrous Ammonia 9% Liquid & Urea 6% MAP/DAP
	Manure 32 lbs	42% Dairy / 58% Hog

Phosphorus

Phosphorus is a chemical commonly found in soil, rocks and plants. It is an essential nutrient for plant growth and therefore is an important fertilizer in agricultural production and widely applied across the Minnesota River Basin (see map below). However, phosphorus is also an important contaminant of surface water since even low concentrations can lead to algal blooms (eutrophication). Elevated phosphorus levels is the primary cause of algal growth which is a leading contributor to low dissolved oxygen concentrations in the lower twenty-two mile reach of the Minnesota River during low flow conditions. Further downstream, elevated phosphorus levels can contribute to eutrophication of Lake Pepin. At a national scale, eutrophication is responsible for the hypoxic zone (area of low oxygen) in the Gulf of Mexico (see "Downstream Impacts: Nitrates and the Dead Zone" section for more information).

Sources of Phosphorus

The MPCA approximated primary sources of phosphorus to the Lower Minnesota River as part of Lower Minnesota River Dissolved Oxygen TMDL. Primary sources of Phosphorus included: Wastewater Treatment Facilities 65 percent, Urban stormwater 16 percent, Agriculture 14 percent, direct discharges of sewage 4 percent (MPCA, 2006). For all surface waters in the state, MPCA estimates that 26.4 percent of the total P delivered are attributed to surface runoff from cropland and pastureland during average flow conditions. Agricultural tile drainage, feedlots, and atmospheric deposition accounted for 1.8, 1.0, and 13.1% of the total P contributions during the average flow years, respectively. Furthermore, the study attributes 4.8 percent of the total P in the statewide surface waters to urban runoff during average flow years (Barr Engineering, 2004).

Farm Scale Study

A farm survey conducted in Seven Mile Creek Watershed in 2002 serves as an example of phosphorus use in the basin. Eighteen farms were interviewed totaling 11,000 acres of farmland. The cropland was dominated by a field corn and soybean rotation (93% of all acres). Commercial Phosphorus (P) applications accounted for 75 percent of the total P applied for corn acres with the balance of P contributed from manure (mostly hog). Average commercial fertilizer rate of phosphate across all field corn acres was 36 pounds per acre. A total of 263,000 pounds of P were applied on inventoried fields (MDA 2002).

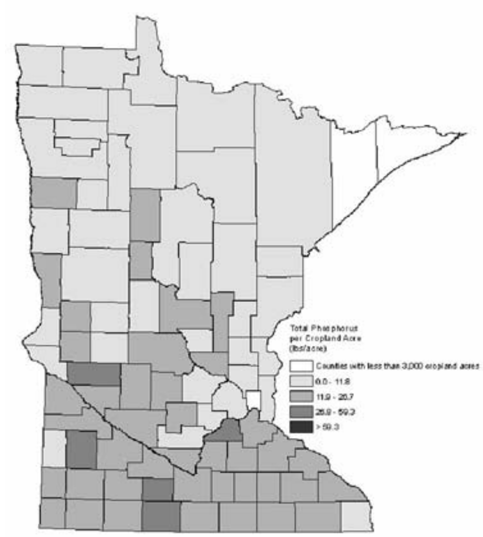
Destination of commercial phosphate used on field corn acres

84% Field Corn
12% Sweet Corn
4% Alfalfa

Pat Baskfield

Watonwan River diatom bloom (2007)

Phosphorus Applied



The map above depicts phosphorus input estimates based on 2002 Census data for county fertilizer sales and "fertilizer replacement" values from manure contributions. Inputs are averaged across all cropland acres within each county (Birr et al, 2008). The Minnesota River Basin stands out as a region with higher phosphorus inputs.

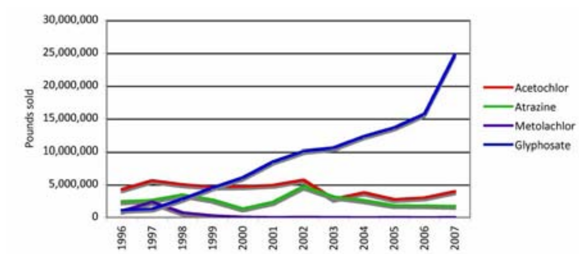
Pesticides

Pesticides

The Minnesota Department of Agriculture (MDA) is the lead state agency for most aspects of pesticide and fertilizer environmental and regulatory functions. The MDA publishes an annual pesticide sales data for pesticide active ingredients and data are currently available from 1996 to the present (http://www.mda.state.mn.us/chemicals/pesticides/pesticideuse.html).

Pesticide Sales in Minnesota 1996-2007

Pounds of pesticides sold

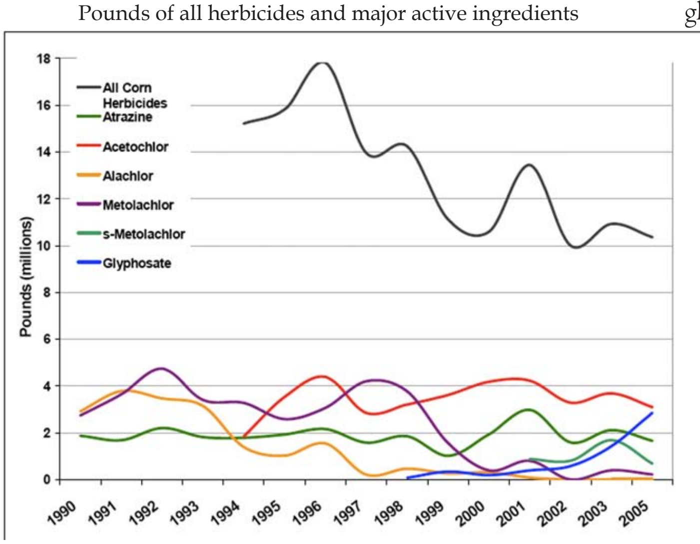


Source: MDA, Pesticide Sales Data. 2009.

The pesticides sales in Minnesota graph above illustrates the general decline in sales of metolachlor, atrazine, and acetochlor and significant rise in glyphosate sales from 1996 to the present. MDA notes that sales data provide an indication of long term pesticide use trends.

Total Corn Herbicide Use Estimates in Minnesota 1990-2005

Pounds of all herbicides and major active ingredients



Source: MDA, 2008

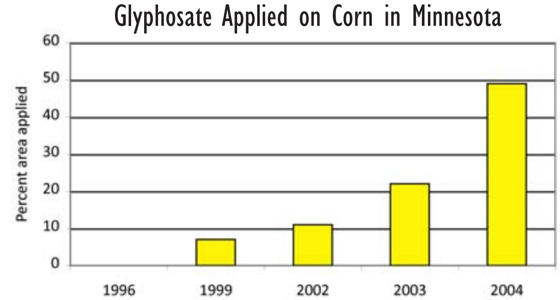
The graph above suggests an overall decline in pesticide usage on corn. With the increased use of the herbicide glyphosate on corn (shown in blue line) there has been a general decrease in the use of historically popular corn herbicides such as atrazine and acetochlor (MDA, 2008).

Rise of Glyphosate Tolerant Crops and Glyphosate

A significant trend in the past decade is the increase in the amount of glyphosate being applied on Minnesota corn and soybean acres across the Minnesota River Basin. The active ingredient glyphosate is a broad-spectrum herbicide marketed under several brand names, the most common being Roundup. Farmers apply glyphosate as a post-emergence herbicide against most broadleaf and grassy weeds. Roundup is produced by Monsanto who also produces Roundup Ready seeds that grow into plants genetically engineered to be tolerant to glyphosate. The genes contained in these seeds are patented.

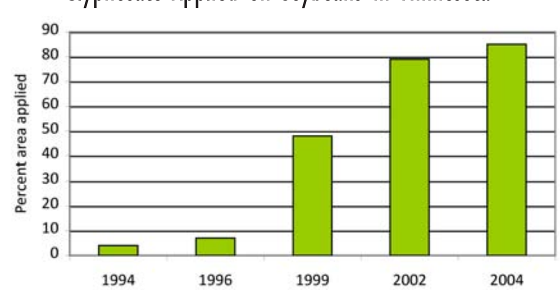
In 1996, genetically modified soybeans tolerant to glyphosate became commercially available, followed by glyphosate tolerant corn 1998. The graphs (below) show the rise in the use of glyphosate on both corn and soybean acres in Minnesota over the past decade. Virtually all (approximately 98%) of acres planted with glyphosate tolerant soybeans are treated with glyphosate. Approximately 85 percnt of acres of glyphosate tolerant corn are treated with glyphosate (Gunsolus, 2009).

Glyphosate Applied on Corn in Minnesota



Source: Gunsolus, 2009

Glyphosate Applied on Soybeans in Minnesota



Source: Gunsolus, 2009

A University of Minnesota agronomist estimates that by 2008, approximately 85 percent or more of the corn acres planted in Minnesota are glyphosate tolerant and 95 percent of the soybean acres are glyphosate tolerant (Gunsolus, 2009).

Pesticides continued

Commonly Used Pesticides (Analytes)	Pesticide Type	Trade Name Examples
Acetochlor	Herbicide	Surpass, Harness
Atrazine	Herbicide	Atrazine, Aatrex
s-Metolachlor	Herbicide	Dual, Brawl
Glyphosate	Herbicide	Roundup, Rodeo

Minnesota Department of Agriculture

Farm Pesticide Use Studies

To better understand pesticide use in Minnesota, the MDA conducts surveys designed to understand existing farm practices regarding agricultural inputs such as fertilizers, manures and pesticides. The surveys find that corn and soybean acreage accounts for the majority of pesticide application statewide. Pesticides are applied to over 95 percent of the major crops in surveyed areas. For more information about the studies, see the MDA website: http://www.mda.state.mn.us/appd/pesticides/pesticideuse.htm

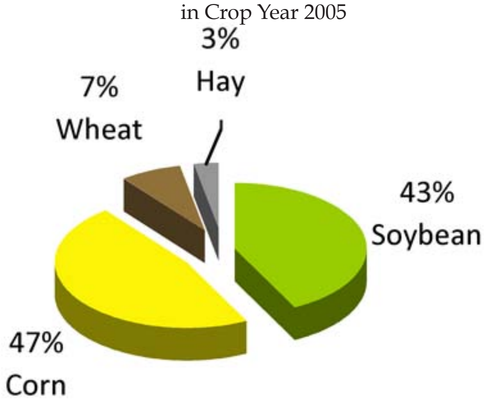
Pesticide Use on Four Major Crops in Minnesota

Minnesota Department of Agriculture performed a study of Pesticide Usage on Four Major Crops in Minnesota (Corn, Soybeans, Wheat and Hay) in 2005. Collectively these crops account for over 90 percent of Minnesota's cropland. Survey results from Pesticide Monitoring Region (PMR) 6 provides a case study for the Minnesota River Basin. PMR 6 lies entirely within the Minnesota River Basin and includes the following counties: Big Stone, Chippewa, Lac qui Parle, Stevens, Swift, and Yellow Medicine (see map below) (MDA, 2007).

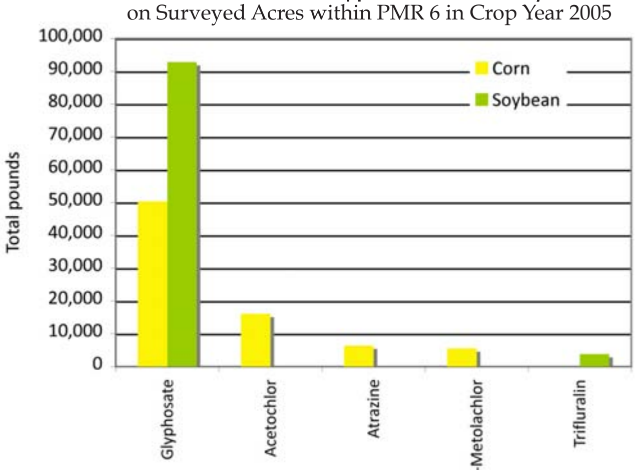
Pesticide Use Study

Source: MDA, 2007

Crop Type
Percent of Acres Surveyed in PMR 6
in Crop Year 2005



Pounds of Pesticides Applied to Corn & Soybeans
on Surveyed Acres within PMR 6 in Crop Year 2005



The graphics at left and below show farm survey results for PMR 6. These results reflect the recent increase in use of glyphosate on both corn and soybean acres.

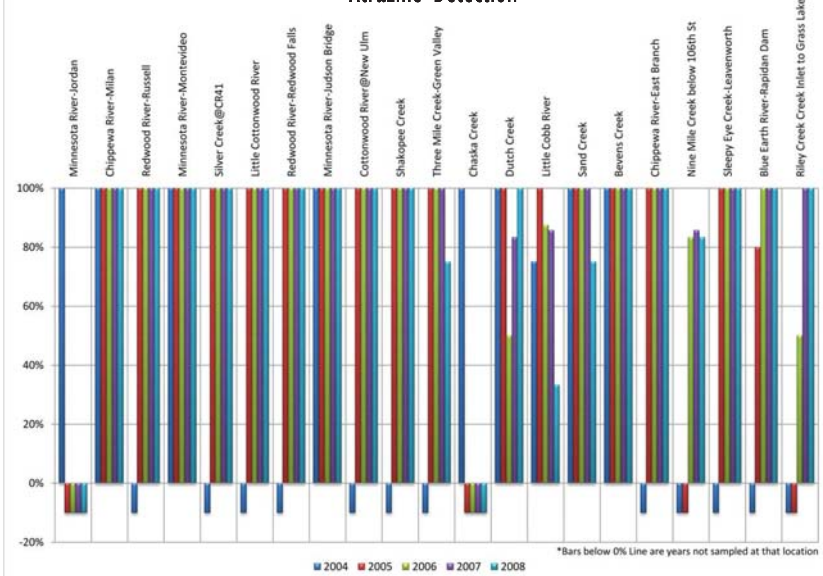
Corn Highlights (PMR 6): Herbicides, insecticides, and fungicides were applied to 97 percent, 18 percent, and 0 percent, respectively, of the surveyed corn acres. The top three herbicide products (based on percent acres covered) were glyphosate (48%), acetochlor (25%), and atrazine (24%).

Soybean Highlights (PMR 6): Herbicides, insecticides, and fungicides were applied to 98 percent, 44 percent, and 3 percent, respectively, on the surveyed acres of soybeans. Glyphosate products were applied to 89 percent of the acres. No other herbicides were applied on more than 4 percent of all soybean acres (MDA, 2007).

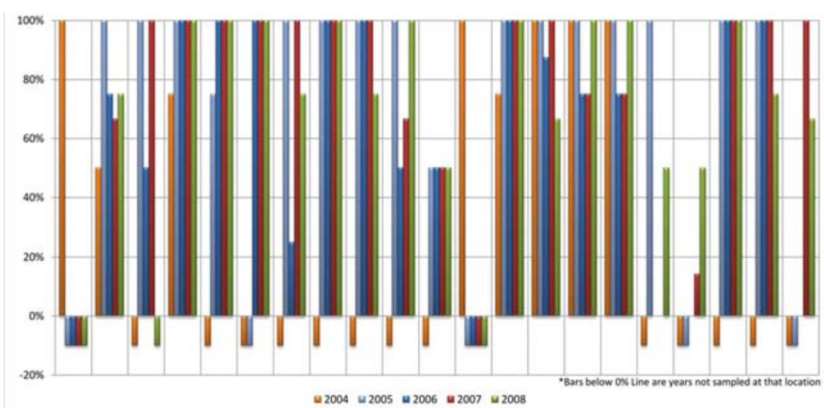
Pesticides Detected in Rivers and Streams

The MDA Monitoring and Assessment Unit collects water quality samples to evaluate pesticide detection patterns and to evaluate the presence of commonly used pesticides in the rivers and streams and groundwater across the state. In the Minnesota River Basin, the herbicides atrazine, metolachlor. and acetochlor, are the most frequently detected compounds in rivers and streams. The graphs below show percent detection for MDA pesticide monitoring sites within the basin from 2004-2008.

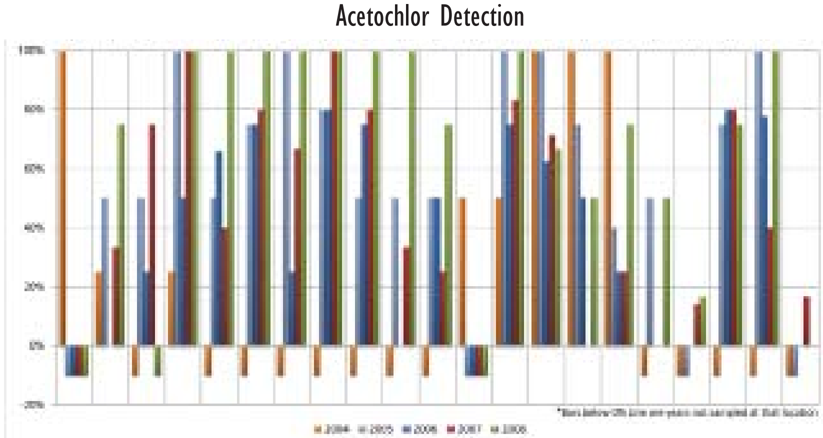
Atrazine Detection



Metolachlor Detection



Acetochlor Detection



Animal Agriculture

Hogs, cattle, and poultry industry in the basin

Minnesota Soybean

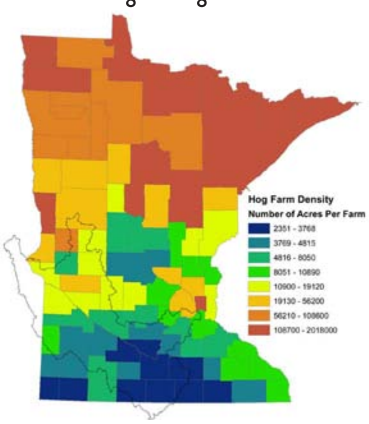
Rapid changes have taken place in animal agriculture in recent decades. Since the 1980's there has been increased concentration in production of dairy, swine, and poultry industry across the state and within the Minnesota River Basin. Livestock raising is a significant business in the Minnesota River Basin. There are approximately 10,000 feedlots in the basin. Registered feedlots contained about 2 million animal units in 2006 (MPCA, 2007). Roughly 5 percent of feedlots are larger than 1,000 animal units.

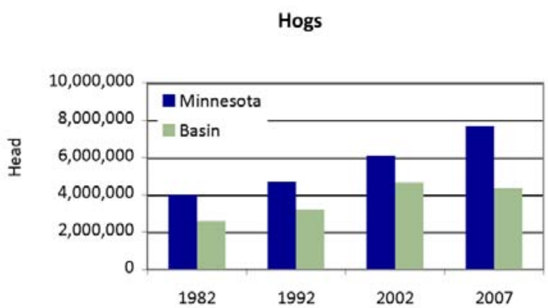
Hogs

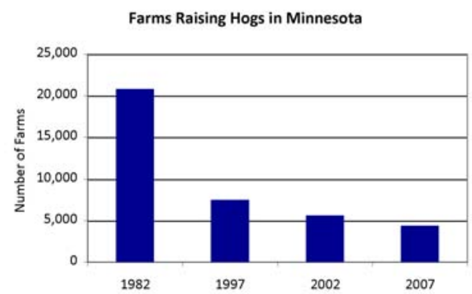
Minnesota Soybean

Minnesota is ranked third in the nation for production of hogs and pigs (approximately 7,500,000 produced in 2007). In Minnesota, the swine industry has traditionally relied on family farm production as part of a diversified farming strategy, but between 1982 and 2007, the number of farms raising hogs decreased dramatically while the number of hogs raised on Minnesota rose dramatically. In 1982, the average hog farm had 216 hogs while by 2007 the average rose to 1,757 hogs per farm.

Farms in Hogs & Pigs 2007

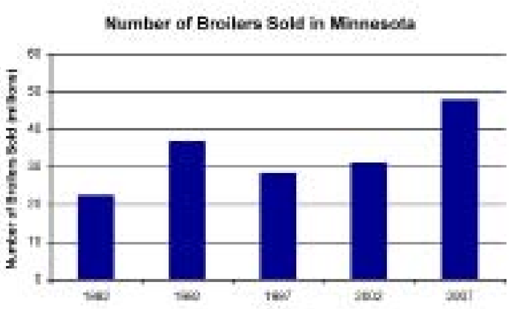






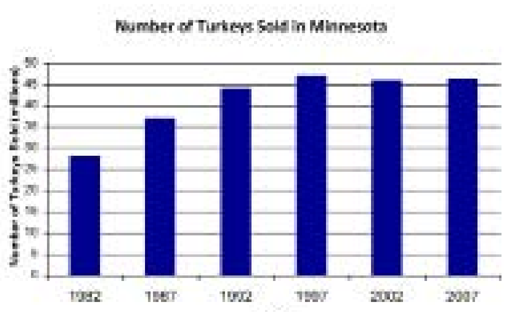
Poultry

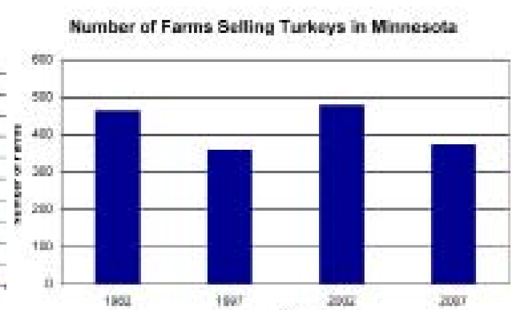
Minnesota is ranked first in the nation for turkey production (approximately 18,000,000 turkeys produced in 2007). The expansion of the poultry sector began in the 1950s in Minnesota and has continued into the present. From 1982 to 2007 the number of farms selling broilers and turkeys both decreased. The number of broilers sold increased significantly in 2007 while the number of turkeys sold maintained a more steady increase.



Minnesota Soybean

Minnesota Soybean



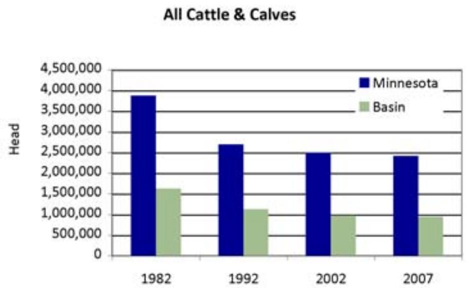


Animal agriculture continued

Minnesota Soybean

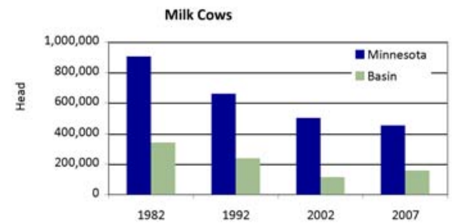
All Cattle and Calves

The total number of cattle and calves in Minnesota and in the basin have declined since 1980s.



Dairy

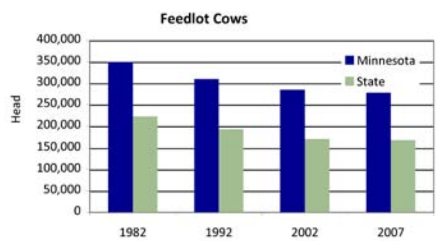
Between 1982 and 2007 the number of farms in Minnesota with dairy cattle steadily and rapidly declined. In 1982, there were 24,178 dairy farms with the average herd size of 20 cows. By 2007, there were only 5,148 dairy farms with the average herd size increased to 89 cows.

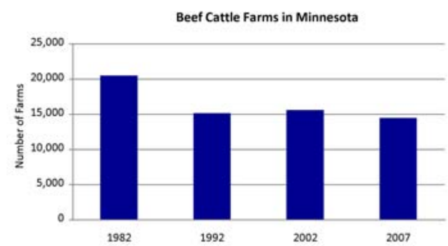


Beef

The number of beef cattle farms and herd size in Minnesota declined between 1982 and 2007 with only a small increase in average herd size (23 to 28 cows) over the time period.

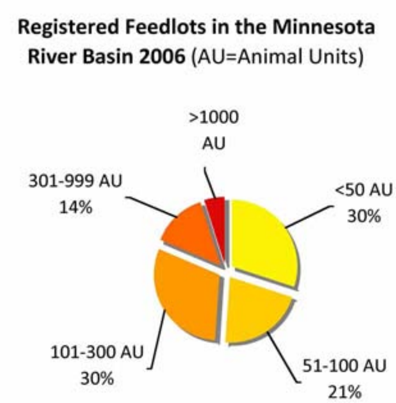
Minnesota Beef Council





Feedlots and Manure Management

Manure management is increasingly important because of the larger livestock populations and increased concentration of production in the basin. More livestock per facility means more manure to manage. The Minnesota Pollution Control Agency (MPCA) is the principal agency for regulating feedlots in Minnesota. The MPCA, by law, may also delegate some of its feedlot program responsibilities to counties.



There are approximately 30,000 feedlots in Minnesota and approximately 30 percent lie within the Minnesota River Basin. In 2006, there were approximately 8,772 registered feedlots in the Minnesota River Basin (MPCA, 2007). Proper manure management is important to protecting ground and surface water. If manure is not handled properly it can be a source of bacteria, nutrients, ammonia and total suspended solids.

Land application of manure is the primary source of annual loading of feedlot-related nutrients to surface water (compared with manure spills and feedlot runoff) (Environmental Quality Board, 1999). Broadcasting manure onto a field is the oldest method of spreading. Another method involves broadcasting the manure and incorporating the manure into the soil within a few days. For liquid manure, injecting manure with chisel-type knife has become popular. Near waters, manure must be incorporated after application and generally will be applied over a greater number of acres to limit soil phosphorus build-up. This applies to any size feedlot (Montgomery, 2002).

Conservation Easements

Conservation Programs

Kevin Kuehner

There have been four major conservation easement programs dedicated to setting aside cropland in sensitive areas to protect and improve water quality. Three of the programs have involved the Federal Government including the Soil Bank program of 1950s and 1960s. Each of the programs has been designed to pay landowners a payment to plant some type of vegetative cover to keep soil on the land. Some of the programs permanently protect the land and others temporary take it out of crop production for a specific time period. All of these are voluntary programs.

1700-1860s
First Europeans explore the Minnesota River and describe a landscape dominated by prairie intermixed with wetlands, shallow lakes, and forested areas on the river floodplain.

1850s
Surveyor's record a landscape covered with wet prairie and wetlands.

1956-1960
Soil Bank Program pays farmers to retire land from agricultural production for up to ten years.

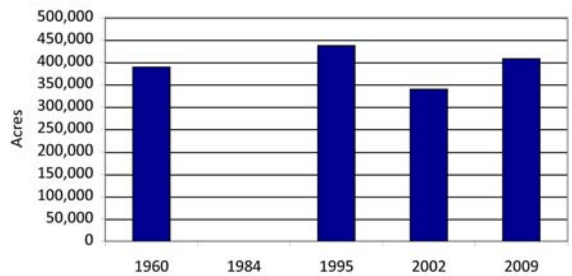
1973-1981
Secretary of Agriculture Earl Butz pushes farmers to plow up more land and expand their operation.

1985
Farm Bill creates Conservation Reserve Program (CRP).

1986
Minnesota develops the Reinvest in Minnesota Program (RIM).

1998-2002
Minnesota River Conservation Reserve Enhancement Program (CREP) enrolls over 100,000 acres of permanent easements.

Conservation Easements in the Minnesota River Basin



Permanent and temporary easements in the basin.

Soil Bank Program

In 1956, the U.S. Congress enacted the Soil Bank Program to divert land regularly used for crop production to conservation uses. Over the next four years farmers enrolled almost 29 million acres into a protective cover crop. Farmers could sign up for 5 to 10 year contracts. Most of the contracts for this program expired in 1969.

Conservation Reserve Program (CRP)

Offered through the U.S. Department of Agriculture (USDA), the Conservation Reserve Program (CRP) offers 10 to 15 year contracts to protect highly erodible cropland or other environmental sensitive acres by planting a vegetative cover including native grasses and trees.

Reinvest in Minnesota Reserve (RIM)

As one of the first of its kind programs in the U.S., Reinvest in Minnesota Reserve (RIM) pays landowners a percentage of the assessed value of their land to enroll it into a conservation easement to protect and improve water quality by restoring wetlands and planting native grass and/or trees.

Conservation Reserve Enhancement Program (CREP)

To assist in the restoration and protection of the MN River, the Conservation Reserve Enhancement Program (CREP) brought together federal and state funds to pay for permanent easements on critically sensitive cropland. Over 100,000 acres were enrolled in four years.


Scott Kudelka

One of the things we've seen along the river that was not obvious 10 years ago is the abundance of land along the river in the Conservation Reserve Enhancement Program. Today, these acres are visible all along the river, as tall willows and grasses cover land that was once farmed near the river. There are still crops hard against the river bank in places and the occasional cow pasture along the banks, but the farming up close to the river is much less evident than a decade ago. The benefit of returning land to vegetation was evident at a spot near Granite Falls. A former farm field was now covered in vegetation and under several inches of water. Using a clarity checking tube we found the water flowing out of the wetland to be greater than the 60 centimeter maximum in the tube. When we paddled a few yards out to the main channel, that clarity reading dropped to 22 centimeters.

John Cross & Tim Krohn
Mankato Free Press Reporters
Reflecting on changes in the Minnesota River from 1998 to 2008

Best Management Practices (BMPs)

Best Management Practices

A diverse selection of government agencies, watershed projects and nonprofit organizations offer technical assistance and cost-share for a wide variety of conservation practices to help improve water quality by holding both soil and nutrients on the landscape. One of these practices is conservation tillage, defined as any tillage and planting system that covers 30 percent or more of the soil surface with crop residue, after planting, to reduce soil erosion by water runoff. This includes the practices of No-till/strip-till, Ridge-till and Mulch-till.

Scott Kudelka

USDA NRCS

Crop Residue

According to the Natural Resource Conservation Service (NRCS), crop residue left on the surface shields the soil from rain and wind until emerging plants provide a protective canopy. Crop residue also improves soil tilth, adds organic matter to the soil, and may even result in a little grain being left for wildlife. Less tillage reduces soil compaction and saves the farmer time and fuel.

Conservation Tillage

Rice County SWCD

By adopting reduced-tillage methods, farmers help decrease the potential for erosion and loss of soil and phosphorus from cropfields. Recent University of Minnesota research in Scott and Le Sueur counties shows that adoption of reduced tillage is higher for larger farms. As a result, erosion is reduced because there is less soil disturbance. On the negative side, reduced tillage may bring about a greater reliance on chemical versus cultural and mechanical weed control methods, which tend to be more time consuming. Other recent field surveys indicated that the proportion of cropland under reduced tillage is increasing rapidly in the Minnesota River Basin, from single-digit percentages in the early 1990s (1992 NRI data) to 29 percent in 1995 and 42 percent in 1996 (MPCA, 1997).

Stearns County SWCD

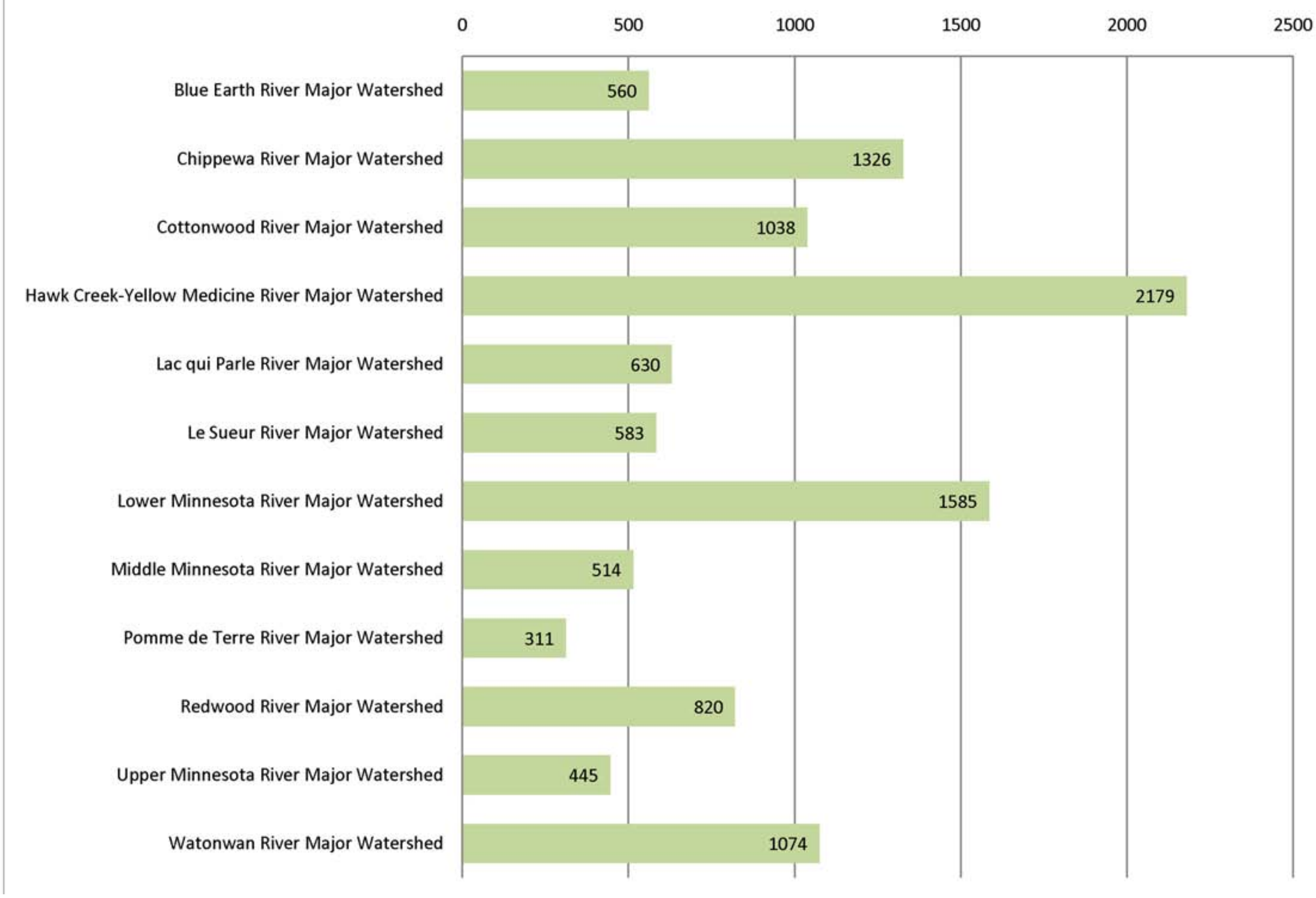
Tillage Transect Surveys

This is an annual survey of cropland to determine the soil erosion rate used to compile statistically accurate data on soil erosion by randomly sampling cropfields (Vernon, WI Soil and Water Conservation District office). Tillage Transect Surveys have been conducted across Minnesota on a fairly regular basis since 1989. A number of organizations have led this effort including NRCS, Minnesota River Board and Minnesota Board of Water and Soil Resources (BWSR).

In 2008, the Water Resources Center at Minnesota State University, Mankato compiled the data from all the surveys in a report to BWSR. According to this report, conservation tillage practices on cropfields have been increasing since the surveys were first conducted in 1989. The report stated, "Soybeans in Minnesota, for many practical reasons, appeared to be a driving force in residue management improvements. Conservation tillage shifted from 20.2 percent of soybean acres in 1989 to 56.6 percent in 2007." On the other hand, residue on corn ground peaked in 1993 at only 27.2 percent.

Additional BMPs are being utilized and implemented across the Minnesota River Basin including filter strips, wetland restoration, grass waterways, shelter belts, riparian buffers, nutrient management, field wind breaks, living snow fences, streambank restoration and structures like water and sediment control basins, grade control structures and alternative tile inlets.

Best Management Practices per Major Watershed in the Minnesota River Basin



The chart above illustrates the Best Management Practices (BMP) recorded in the Minnesota River Basin from 1997-2008. The data is from the Board of Water and Soil Resources (BWSR) LARS (Local Government Annual Reporting System) 1997-2002 and e-Link reporting system (2003-2008). The number of BMP's in the chart reflect only the actual contract for that BMP and not the acres contained in that BMP.

Best Management Practices Timeline

1928: Dr. Hugh H. Bennett publishes the now classic, 1,000-page book titled "Soil Conservation." Today, it is widely recognized as the "menace" bulletin that sparked the modern soil conservation movement.

1930s: Soil conservation efforts go into crisis mode during the devastating decade-long drought that causes massive dust storms to blow across the Great Plains. The federal government creates numerous agencies and programs to tackle this intense problem.

1940s: By the start of World War II, the Soil Conservation Service (SCS) leads the effort to install soil conservation practices under the U.S. Department of Agriculture along with Soil and Water Conservation Districts (SWCD) on the local level.

1950s & 1960s: In 1965 there are 89 SWCD's organized in the state. Over these two decades, SWCDs go from demonstrating conservation practices to providing planning and engineering assistance. One of the major programs of this time period is the Soil Bank Program, setting aside cropland from production in a ten-year easement.

1960s to 1985: SWCDs began to promote crop residue management / conservation tillage as an erosion control measure. In 1976, the State Cost-share Program is put in place to help pay for conservation practices.

1985: New Farm Bill creates the Conservation Reserve Program (CRP), conservation compliance along with the swampbuster and sodbuster provisions.

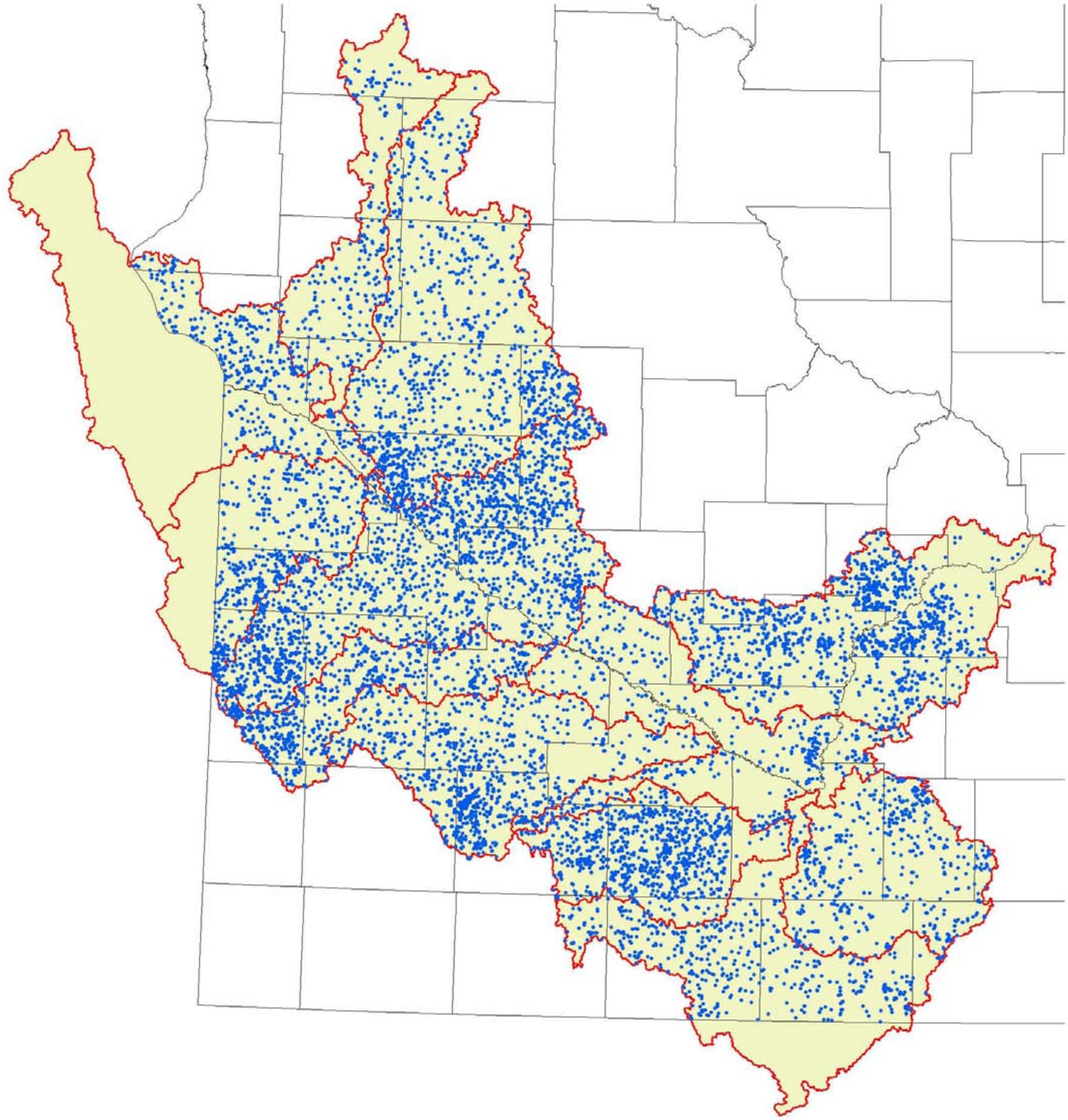
1980s to 1990s: Reinvest in Minnesota Program (RIM) is launched in 1986 to help protect critically sensitive lands and a year later the Board of Water and Soil Resources (BWSR) forms from three separate agencies.

Today: Ninety-one SWCDs operate across Minnesota working with government agencies on the local, state and national levels, along with watershed projects and citizen groups to promote and install best management practices.

"Through these eyes: The First 70 Years of Soil and Water Conservation in Minnesota" by Vic Ruhland; Minnesota Office, USDA, Natural Resources Conservation Service.

Best Management Practices in the Minnesota River Basin

Based on BWSR's e-Link and LARS databases 1997-2008



The map above illustrates the Best Management Practices (BMP) recorded in the Minnesota River Basin from 1997-2008. The data is from the Board of Water and Soil Resources (BWSR) LARS (Local Government Annual Reporting System) 1997-2002 and e-Link reporting system (2003-2008). Please note that the data was mapped based on location and only indicates the point location of the BMP and does not reflect the acres contained in that BMP. The map illustrates the differences in density of BMPs among major watersheds.

Wastewater

Significant Phosphorus reduction

Wastewater Treatment Plants have already met the 2010 state goal of 35 percent reduction in the amount of phosphorus plants carry into the Minnesota River.

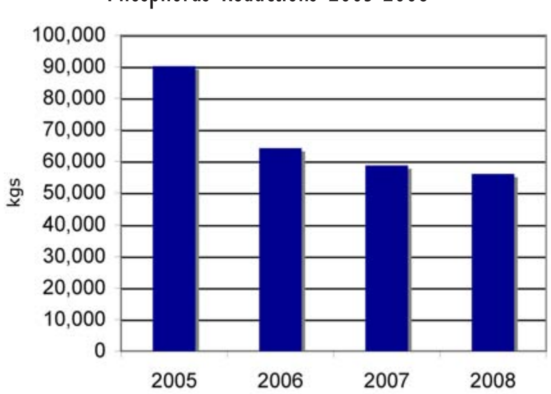
Municipal Wastewater Treatment

There are 152 permitted municipal and industrial wastewater treatment facilities in the basin. Phosphorus from these facilities is a particular concern because it is the nutrient primarily responsible for the eutrophication of Minnesota's surface waters. Eutrophication is a process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that can stimulate excessive plant growth. This enhanced plant growth, often called an algal bloom, reduces dissolved oxygen in the water when dead plant material decomposes and can cause other organisms to die.

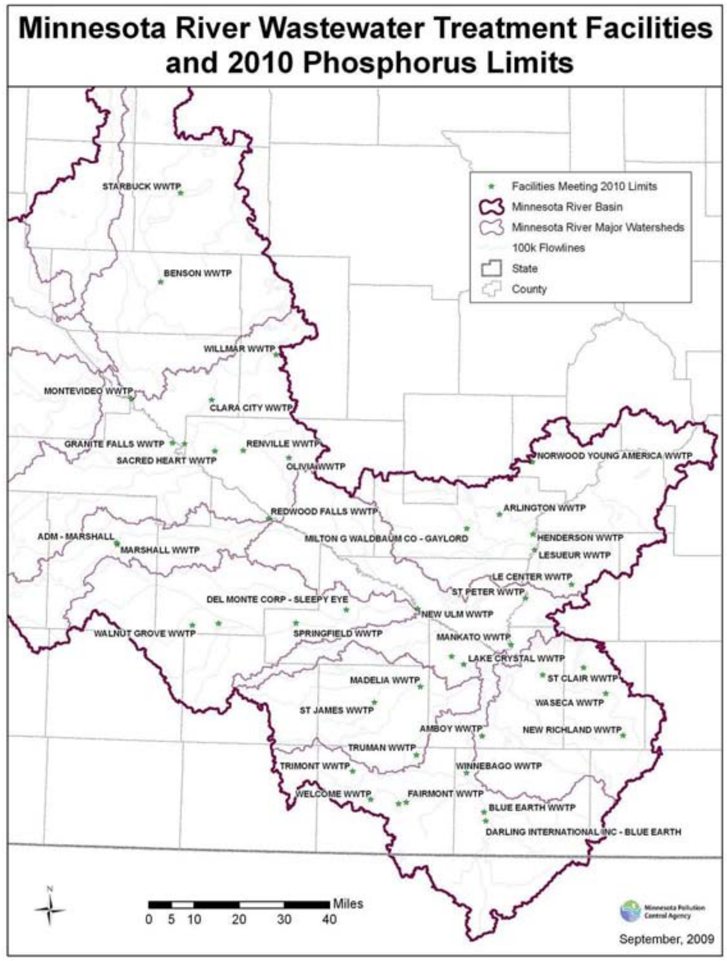
Hundreds of millions of dollars have been invested to upgrade wastewater treatment plants across the basin. In 2005, Minnesota developed a Phosphorus General Permit to reduce phosphorus discharged by point sources into the Minnesota River Basin. Forty-seven of the 152 facilities are required to reduce phosphorus as part of this General Permit. Under the permit, the point sources have the option of trading to meet their water quality-based effluent limits. Trading also allows new or expanding dischargers of phosphorus the opportunity to purchase phosphorus loads from others to offset their new or increased phosphorus load. Seventeen trades occurred in 2008 under the permit.

The Phosphorus General Permit sets effluent limits in stages: 15 percent by 2008, 25 percent by 2009, 35 percent by 2010 and 50 percent by 2015. As of Summer 2009, collectively the 47 facilities are meeting their 2010 limits (see map at right). Twenty-four facilities are at or below their individual 2010 goal. Three more were upgraded in 2008 and should be in line by the end of this season.

Phosphorus Reductions 2005-2008



The chart above shows the reduction in the amount of phosphorus being discharged into the Minnesota River due to wastewater treatment plant upgrades.



Minnesota River Phosphorus Reductions— Highlighted as an EPA Success Story

"The Metropolitan Council owns and operates eight municipal wastewater treatment plants in the Twin Cities metropolitan area of St. Paul and Minneapolis. Since 1990, the Council has achieved dramatic reduction in phosphorus discharged from its plants to area receiving waters. Since the peak of phosphorus discharge in 1995, the Council has achieved a 78 percent reduction in phosphorus loads.

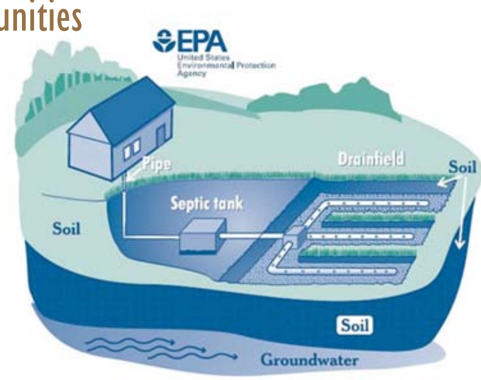
To understand the magnitude of such a reduction, it would be as if we went back to before 1900. At that time, the metropolitan area had a population of 500,000 people and an estimated 1,860 pounds per day of phosphorus was discharged to area rivers. Today, two million more people live in this area, yet discharge only 1,670 pounds per day" (EPA, 2009).

Septic Systems & Undersewered Communities

Significant progress addressing undersewered incorporated communities

Compliant Private Systems

There are many effective private septic systems across the basin. Septic systems consist of a septic tank connected to a drainfield (see diagram at right) and are an effective means for treating wastewater. When properly sited, installed, and maintained individual septic systems remove most of the bacteria and viruses in the wastewater within two to three feet below the drainfield. Individual sewage treatment systems are regulated by local governments in Minnesota, primarily counties, although cities and towns may also choose to regulate the systems (BID, 1997).



Non-compliant Private Sewage Systems

Surveys conducted in southern Minnesota show that many systems lack the soil treatment system component (the drainfield) of the septic system, and wastewater from the septic tank is allowed to flow into tile drains or drainage ditches. In these situations the effluent, which contains solids, bacteria, viruses, and organic materials, enters the surface water without being treated by the soil treatment system. Surface discharges of sewage can present health problems due to pathogens that may be present. Additionally, a septic system that fails to fully treat sewage allows excess nutrients (phosphorus and nitrogen) to reach nearby lakes and streams, promoting algae and plant growth. Algal blooms and abundant weeds may make lakes and rivers unpleasant for swimming, boating, and other water-based activities.

Counties submit yearly annual reports to the MPCA, which include local estimates of imminent public health threat septic systems (see chart below). These estimates also include systems that are not Imminent Threats, but are classified as Failing to Protect Groundwater. All systems and small communities classified as Imminent Threats to Public Health and Safety are illegal under Minnesota rules (MPCA, 2007).

	1990*	2004**	2008**
Estimated Total Number of Septic Tanks	67,630	79,722	77,155
Estimated Failing Systems	(No data)	27,710 (35%)	24,790 (32%)
Estimated Imminent Threat to Public Health or Safety (IPHT)*** (Discharge to surface)	30,000 (44%)	20,000 (25%)	17,279 (22%)

* Estimate based on 1990s work completed as part of the Minnesota River Assessment Project and included interviews in 37 minor watersheds within 9 major watersheds and may be conservative.
** Based on county reports to MPCA based on estimates in their record keeping. For 2008, Hennepin's 2007 data and Lyon's 2006 data were substituted due to a lack of data.
***Imminent threat to public health or safety (IPHT) means situations with the potential to immediately and adversely affect or threaten public health or safety, including ground surface or surface water discharges and sewer back up into a dwelling or other establishment. IPHT are sometimes called straight pipe systems. Straight pipe systems include toilet waste and transports raw or partially settled sewage directly to a lake, stream, drainage system or ground surface.

Upgrades Make a Difference

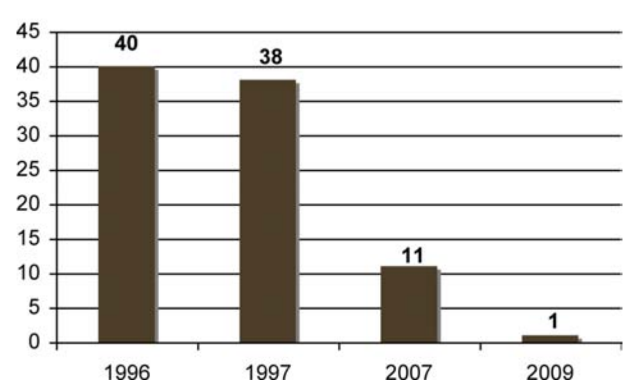
Recent research in the Seven Mile Creek Watershed (Nicollet County) shows that replacing straight-pipe discharges with good septic systems does make a difference. Watershed staff documented the before-and-after impacts of one straight-pipe upgrade in reducing bacteria levels in the creek. In this study, a straight-pipe system was upgraded to a mound and bacteria concentrations from the pipe were reduced to near zero immediately.

Before: Monitoring shows that average E. coli bacteria levels from the suspected tile line were three times higher than EPA's proposed water quality standards for streams like Seven Mile Creek. Number of samples exceeding standard: 72%
After the Upgrade: E. coli bacteria reductions from the suspected drainage tile were immediate. Overall, the septic upgrade reduced drainage tile water E. coli concentrations by 98 percent. Number of samples exceeding standard: 0% (Kuehner & Matteson, 2006).

Undersewered Communities & Unincorporated Areas

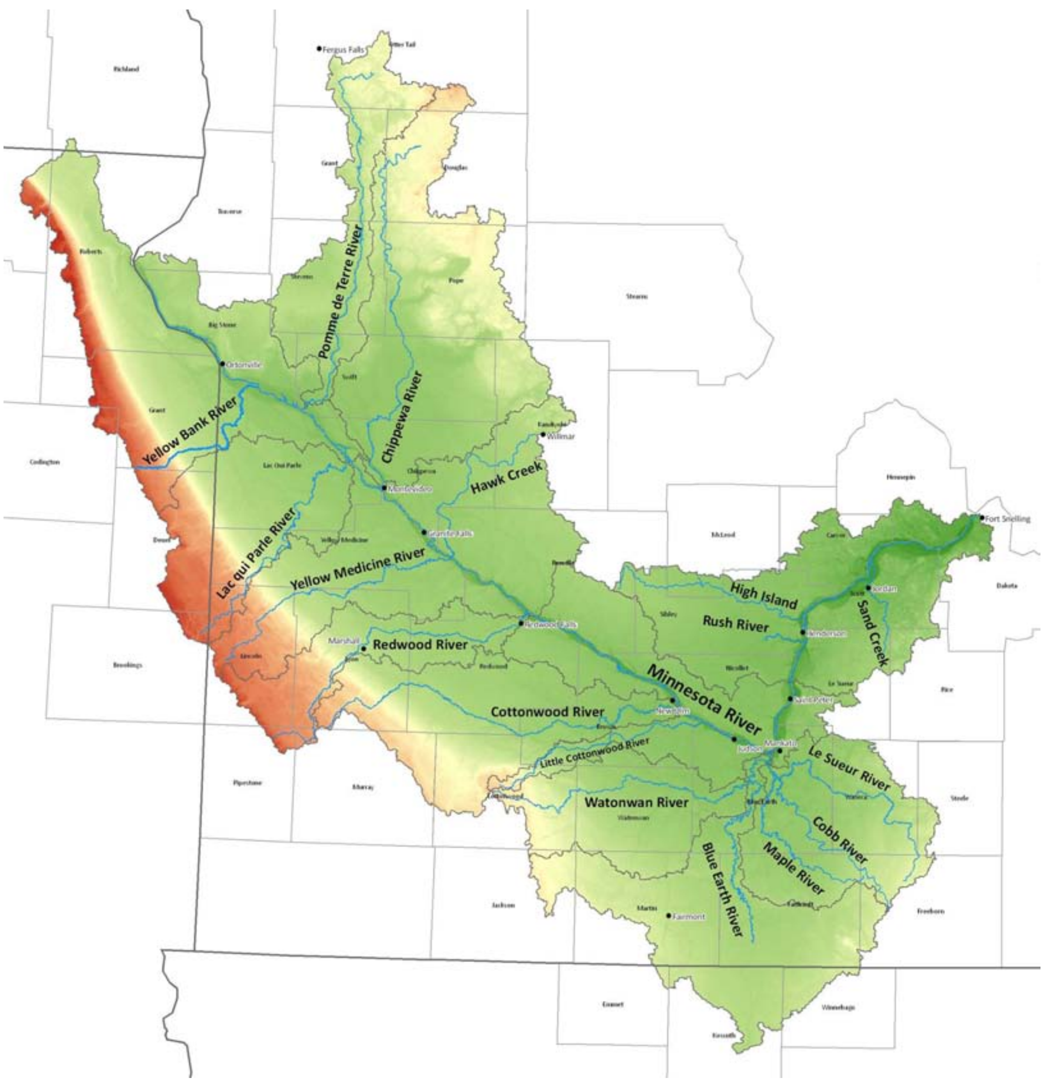
Across the basin, there are also small incorporated communities that are undersewered. Local governments have been fixing this problem by installing their own systems or sharing it with a neighboring community. Significant progress in this area is shown as 39 communities in the basin have addressed the problem since 1996. By 2009, only one facility remains to be addressed (Heidelburg). A goal of the MPCA is to have all wastewater in Minnesota adequately treated by 2011. Undersewered small unincorporated areas are another source of pollution. Although there is no basin-wide sampling data for these areas, the MPCA continues efforts to see that these areas and remaining undersewered communities treat their wastewater. Here's link to learn more about small community wastewater needs: http://www.pca.state.mn.us/publications/wq-wwtp1-06.pdf

Undersewered Incorporated Communities in the Minnesota River Basin



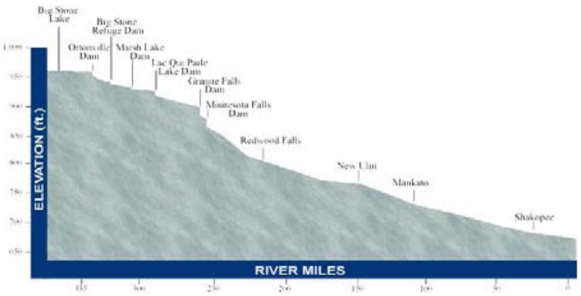
Rivers & Streams

The Minnesota River drains a basin of 14,840 square miles including all or parts of 37 counties; 1,610 square miles in South Dakota and the remaining area in North Dakota and Iowa. The Minnesota River meanders 335 miles from where it originates on the Minnesota-South Dakota boarder to its confluence with the Mississippi River near Fort Snelling. Surface water flow to the river comes from 1,208 minor watersheds. The Minnesota River Basin is divided into 12 hydrologic major watersheds and 13 management watersheds. The following section provides an overview of water quality trends in the basin. More detailed information about surface water quality monitoring can be found in the State of the Minnesota River reports:
http://mrbdc.mnsu.edu/mnbasin/state/index.html



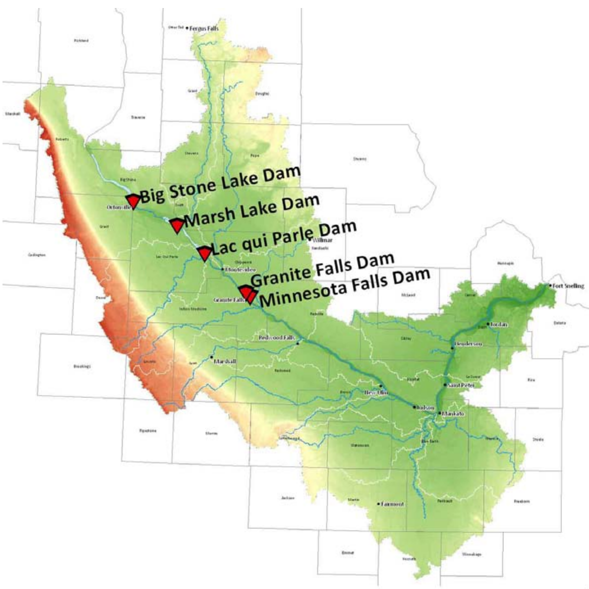
On September 22, 1992, Governor Arne Carlson stood on the banks of the Minnesota River in Bloomington while holding a jar of dirty water and declared it was time to clean up this waterway. "Our goal is that within 10 years, our children will be swimming, fishing, picnicking and recreating at this river," Governor Carlson stated. After years of neglect, citizens, government agencies and nonprofit groups began to focus on restoring, improving and protecting the Minnesota River. In the span of a decade the river was listed as one of the most Endangered Rivers in the nation, the focus of a watershed-wide study – Minnesota River Assessment Project and saw the enrollment of over 100,000 critically sensitive acres into permanent easements.

River Profile



The Minnesota River falls 274 feet from its headwaters at Big Stone Lake (964 feet) to the confluence with the Mississippi (690 feet). It drops approximately 0.8 feet per mile.

Dams on the Minnesota River



There are five major dams on the Minnesota River. Dams have been constructed at the outlets of Big Stone Lake, Marsh Lake, and Lac qui Parle to control lake levels and floodwaters. These dams create extensive lakes which are important wildlife management areas and hunting grounds. The other two dams are located in Granite Falls and a few miles downstream from Granite Falls called Minnesota Falls Dam.


Scott Kudelka

Granite Falls dam

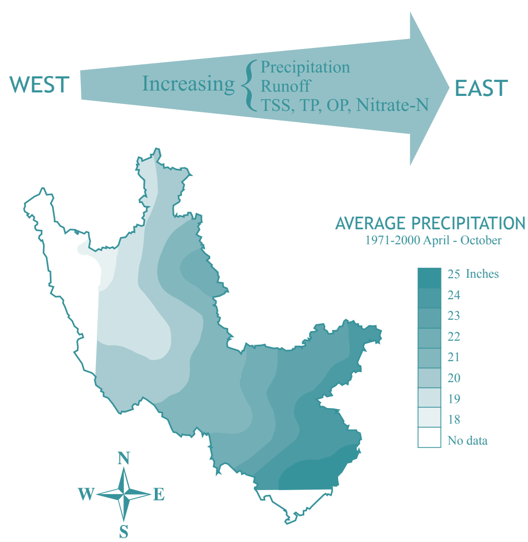
Climate Change & Precipitation

In the 1930s, many parts of the United States including Minnesota suffered through one of the driest periods in recorded history. Beginning around 1936, the average rainfall amount in Minnesota has steadily increased along with some extreme wet and dry years. According to the Minnesota Pollution Control Agency, precipitation in some areas of the state has increased by up to 20 percent, especially in the southern half.

Minnesota's location in the middle of the continent results in a variable climate due to the variety of air masses that flow across the state. Winters are typically dominated by cold, dry continental polar air and also occasionally replaced by somewhat milder maritime polar air (State Climatology Office, 2004). During the summer, Minnesota usually sees a clash between hot and dry continental tropical air masses from the desert southwest and the moist maritime tropical air coming up from the Gulf of Mexico.

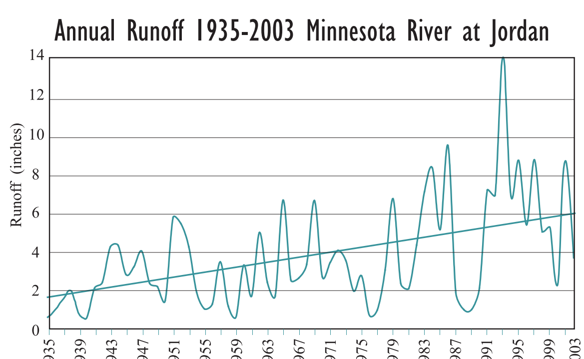
Precipitation is projected to increase by around 15 percent in the winter, summer and fall, with little change during the spring season according to MPCA. This state agency also projects a likely increase in the number of heavy rainfall events during the summer and the frequency of extremely hot days.

Precipitation



The Average Precipitation 1971-2000 map illustrates the west-to-east precipitation and runoff gradient. There is more rainfall as one moves eastwardly across the basin. Yields of key water quality pollutants (TSS, TP, OP and nitrate-N) follow this same general pattern of increasing in an easterly pattern.

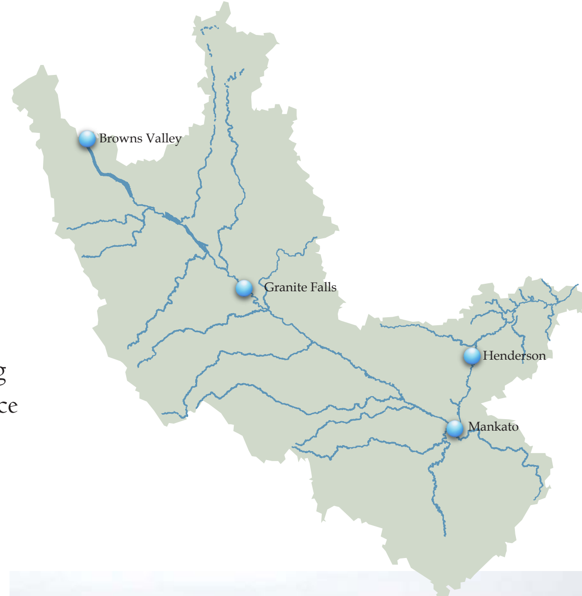
Runoff



The annual runoff 1935-2003 graph illustrates the trend of increasing runoff volume over the past several decades. There is highly variable runoff from one year to another.

Rivers & Streams: Flooding

A natural and "man-made" phenomenon



Flooding is a natural occurrence of a river's riparian zone and provides many benefits including groundwater recharge, settling out sediment and supporting valuable wildlife habitat. A flood occurs when a waterbody like the Minnesota River receives a greater volume of water than it can handle, either at spring snowmelt or during a heavy rainstorm. Flooding only becomes a concern to humans when they impact the river's floodplain either by adding structures or planting crops. Humans have added to flooding problems primarily by intruding on the natural floodplain, but also by increasing the amount of impervious surface on the terrain and by displacing other natural storage on the landscape.

Browns Valley

Situated on a convex alluvial fan of the Little Minnesota River that drops rapidly some 780 vertical feet as it flows out of the Coteau des Prairies, the city of Browns Valley has dealt with major flooding issues since it was established in 1866. Most recently on March 4, 2007, the town was overwhelmed by intense and disasterous flooding when rapidly melting snow and ice jams forced the evacuation of about 100 people. The Little Minnesota River alluvial fan has partially filled the Glacial River Warren spillway in which it is located to form a very unique and dynamic quasi Continental Divide between the Red River and the Minnesota River basins. The convex form of the still actively forming alluvial fan and subsequent continental divide may distribute discharge from the Little Minnesota River north, east and south as different times or at the same time depending on the amount of discharge and the distributary nature of the stream channel at a particular point in time.

JOR Engineering

"Mother nature and humans have unwittingly concocted one of the most complex flood situations ever imagined at Browns Valley."– Dave Craigmile

Dave Smiglewski

John Cross

Granite Falls

One of two cities with development on both sides of the Minnesota River, Granite Falls has been hit hard by flooding including 1997 (11.3 feet above flood stage) and 2001 (7.3 feet) with considerable damage to both residential and commercial buildings. To mitigate some of the flooding problems, the city has built a retaining wall and incorporated it with buildings located along the river, relocated other businesses and homes and put in additional flood prevention measures. In the near future, city officials hope to improve the levee, relocate City Hall and build a new water treatment plant out of the floodplain.

What Increases the Flooding Risk?

- Removal of stabilizing vegetation around stream banks and rivers
- Erecting structures that deflect or inhibit the flow of floodwaters
- Constructing bridges, culverts, buildings, and other structures that encroach on the floodplain.
- Drainage systems that funnel stormwater quickly into a receiving body of water like the MN River.
- Straightening meandering watercourses to hasten drainage.
- Filling and dumping of debris in floodplains.

Flooding continued

Mankato Free Press

Mankato Free Press

Scott Kudelka

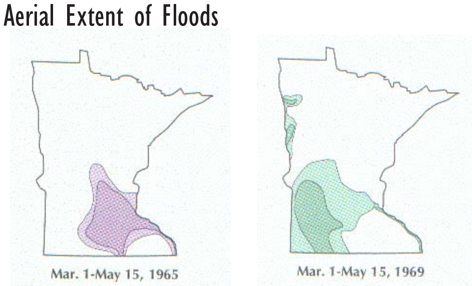
Mankato & North Mankato

Construction of a Flood Control System by the U.S. Corps of Engineers after the devastating 1965 flood has spared Mankato and North Mankato from any serious flooding since that time. Mankato is located at the confluence of the Blue Earth and Minnesota rivers. A doubling of water flow caused wide-spread flooding in 1881, 1908, 1916 and 1951 before the final major flood event in 1965. Today, both cities are protected by a flood wall levee system started in 1959 and finished thirty years later on each side of the Minnesota River along with sluice gates, additional gates and values, large pumps and pumping stations. Mankato and North Mankato have begun to make strides to make the Minnesota River a community asset.

Henderson

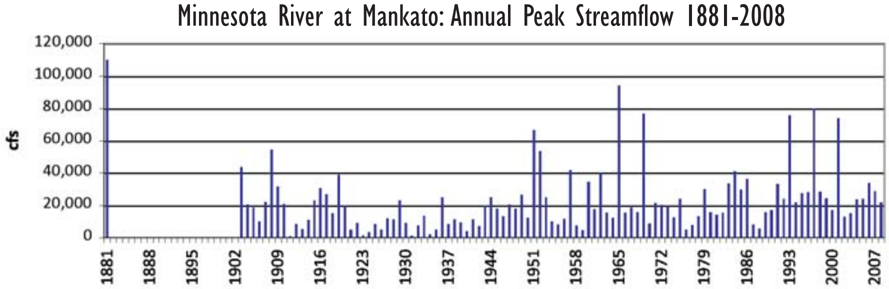
One of the historically significant towns along the Minnesota River, Henderson has been able to protect itself from flooding problems and still maintain some of its connection to the river. The 1965 flood hit this small community hard with a crest of 31.4 feet (highest in history). Approximately 285 people were evacuated from 95 homes. A $2.4 million levee system was completed by the U.S. Corps of Engineers in 1990 surrounding the city on three sides. This 1.5 mile permanent levee protected Henderson during the 1993, 1997, and 2001 floods along the Minnesota River. Today, residents enjoy a walking trail on top of the levee providing a close-up view of the Minnesota River floodplain.

Aerial Extent of Floods



Source: Minnesota Floods and Droughts

Minnesota River at Mankato: Annual Peak Streamflow 1881-2008



Source: USGS

Major Floods 1881-2009: Historical Crests at USGS Gaging Sites

	1881	1919	1951	1952	1965	1969	1986	1993	1997	1998	2001	2009
Savage			3	4	4	4	2	4	4		4	
Shakopee			3	3	4	3		3	3	2	3	
Jordan					4	3	2	3	3		3	
Henderson					4	3		4	3		3	
Mankato	3		2	2	3	3		4	3		3	
New Ulm						4			4	2	4	2
Granite Falls		3	2	3	2	4					3	
Montevideo		3	3	4	3	4	3	3			4	3

4=Major Flood Stage
3=Moderate Flood Stage
2=Flood Stage

Source: USGS

Rivers & Streams: Water Quality

Water Quality Monitoring

State and federal agencies have collected water quality data at various times in various locations throughout the Minnesota River Basin during the past thirty years. The most comprehensive study of water quality Minnesota River Basin, the Minnesota River Assessment Project, was conducted 1989-1994. The study concluded that the Minnesota River was impaired by excessive nutrient and sediment concentrations. Subsequent to those findings, considerable attention and support have been given to clean up efforts. Today, large portions of the Basin do not meet state water quality standards for bacteria, turbidity, dissolved oxygen, ammonia, and biota and are listed on Impaired Waters List (303(d) List). Learn more about Impaired waters on the MPCA website: http://www.pca.state.mn.us/water/tmdl/index.html).

– means decreasing trend/pollutant decreasing
+ means increasing trend/pollutant increasing
NT means no statistically significant trend
ID Insufficient data
mixed means trend tests vary

Pat Baskfield

Rapidan Dam on the Blue Earth River

Water Quality Trend Analysis

Since 2000, surface water quality data across the Basin has been collected and assembled in the State of the Minnesota River reports (produced every two years). These can be found on the Minnesota River Basin Data Center website: http://mrbdc.mnsu.edu. As the length of water quality records grew to a decade in many locations, there was sufficient data to run trend modeling programs to investigate if we can see any water quality trends in the Minnesota River mainstem, major tributary, and minor tributaries.

Minnesota State University, Mankato Water Resources Center recently completed a trend study headed by mathematics professor Deepak Sanjel and an interagency team. The study tested two trend models to examine water quality trends in the Minnesota River Basin: Seasonal Kendall trend model and the USGS Quality of Water trend program (QWTREND). Enough data was available to perform trend tests on 3 mainstem, 8 major tributary, and 4 minor tributary monitoring sites. Each monitoring site was analyzed for four primary water quality pollutants of concern: Total Suspended Sediment, Total Phosphorus, Nitrate-Nitrogen, and Orthophosphorus. A summary of results is presented in the table below. The study is available on the Minnesota River Basin Data Center website: http://mrbdc.mnsu.edu

	Total Suspended Solids	Total Phosphorus	OrthoPhosphorus	Nitrate-Nitrogen
Mainstem				
Judson	–	–	–	mixed
Mankato (SSC)	–	ID	ID	ID
St. Peter	–	mixed	–	NT
Major Tributaries				
Chippewa River	mixed	NT	–	NT
Hawk Creek	–	NT	NT	NT
Redwood River	–	NT	NT	mixed
Cottonwood River	–	NT	–	+
Watonwan River	–	–	–	–
Blue Earth	NT	–	–	–
Le Sueur	+	–	–	–
High Island	NT	NT	NT	NT

Rivers & Streams: Water Quality continued

Comparison of Trend Studies

Percent overall change over time period indicated (Seasonal Kendall Trend Test)

Total Suspended Solids

	Fort Snelling 1976-2001	Jordan 1976-2001*	Blue Earth 1967-2001	St. Peter 1971-2006	Judson 1998-2008
MPCA (Christopherson)	-40%	-31%	-49%	n/a	n/a
University of Minnesota (Johnson)	-48%	-39%	-52%	n/a	n/a
MSU,M Water Resources Center (Sanjel)	n/a	n/a	No Trend	-30%	-28%

Nitrate-Nitrogen

	Fort Snelling 1976-2001	Jordan 1976-2001	Blue Earth 1974-2001	St. Peter 1971-2006	Judson 1998-2008
MCPA	No Trend	No Trend	No Trend	n/a	n/a
University of Minnesota	No Trend	-39% (76-01) -29% (76-02)	No Trend	n/a	n/a
MSU,M Water Resources Center	n/a	n/a	No Trend	-14%	+37

Total Phosphorus

	Fort Snelling 1976-2001	Jordan 1976-2001	Blue Earth 1967-2001	St. Peter 1971-2006	Judson 1998-2008
MCPA	-35%	No Trend	-47%	n/a	n/a
University of Minnesota	-37%	-24% (76-01) -22% (76-02)	-52%	n/a	n/a
MSU,M Water Resources Center	n/a	n/a	-45% (99-08)	-30% (98-08) -47% (71-06)	No trend

* For the Jordan Site, For TSS MPCA analyzed 1976-2001 and U of M analyzed 1976-2002. For Nitrate-N and TP: MCPA 1979-2001, U of M 1979-2002

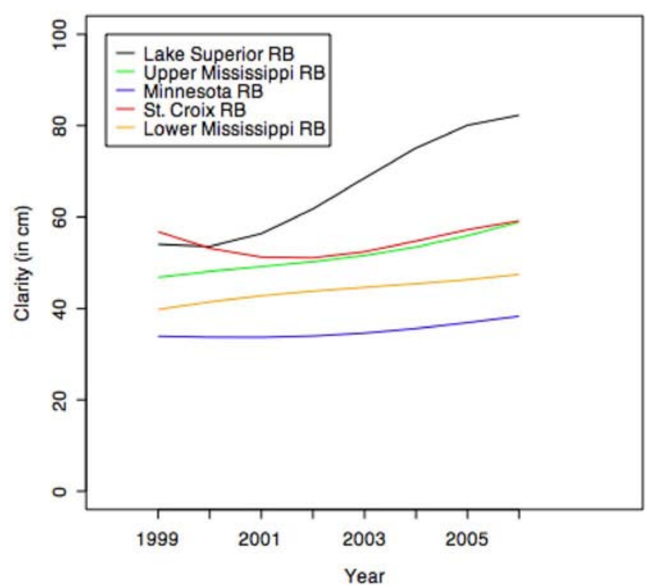
Pat Baskfield

Minnesota River Trend Studies have been performed by Minnesota Pollution Control Agency (Christopherson, 2002), University of Minnesota (Johnson, 2006), and Minnesota State University, Mankato Water Resources Center (Sanjel, 2009). The table at left illustrates that the trend studies all found reduction in TSS and TP in numerous mainstem sites during various time frames. For Nitrate-N, the studies indicated no trends or found mixed results. Taken together, these studies would suggest that at least some aspects of water quality in the mainstem of the Minnesota River have improved and continue to improve.

River Clarity Improving

Another statistical and graphical analysis was performed on data collected as part of Minnesota Pollution Control Agency's volunteer Citizen Stream Monitoring Program (CSMP). The study concluded that streams within the Minnesota River Basin (shown in blue below) had increasing water clarity over the study period 1999-2006 (Le, 2009).

Water Clarity Trends
Major River Basins of Minnesota



Minnesota River Basin Water Quality Links

State of the Minnesota River Reports
http://mrbdc.mnsu.edu/mnbasin/state/index.html

Environmental Data Access — Water Quality Data
http://www.pca.state.mn.us/data/eda/

DNR/MPCA Cooperative Stream Gaging
http://www.dnr.state.mn.us/waters/csg/index.html

MPCA Impaired Waters
http://www.pca.state.mn.us/water/tmdl/

Impaired Waters

More waters have been assessed and listed

What are Impaired Waters?

A water body is considered impaired if the water quality in the stream or lake does not allow it to meet its designated use (such as swimming, fishing or for maintaining a healthy population of fish and other aquatic life). Water quality standards are set on a wide range of pollutants, including bacteria, nutrients, turbidity and mercury. A water body is "impaired" if it fails to meet one or more of Minnesota's water quality standards. The waterbody is then placed on the "303(d)" list, commonly known as the "impaired waters list." It is named after the section of the Clean Water Act in which the impaired waters law is found. Lakes, rivers and streams on the list are known to exceed water quality standards. Every two years, the Minnesota Pollution Control Agency (MPCA) releases the 303(d) list of impaired waters in Minnesota.

Pat Baskfield

Blue Earth River and transparency tube

TMDL Program

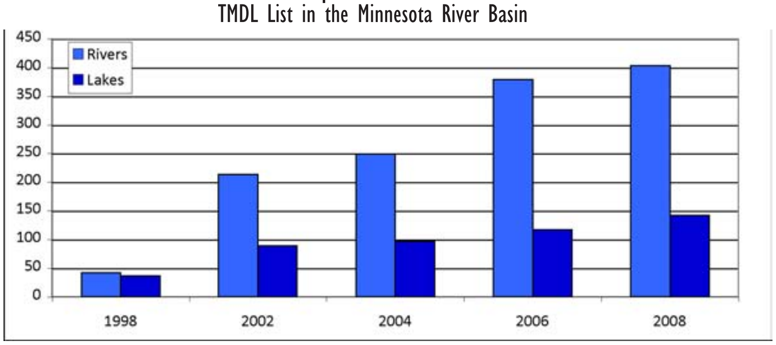
The process of dealing with "impaired waters" comes under the 303(d) Total Maximum Daily Load (TMDL) program. Each state is required to publish and update a list of "impaired waters" under Section 303(d) of the Clean Water Act. According to this act, a TMDL is a calculation of the maximum amount of pollutant from both point and non-point sources, that a waterbody can receive and still meet water quality standards. Once placed on the impaired waters list, the stream or lake needs a water quality improvement (TMDL) plan written.

Minnesota's Impaired Waters

The most recent list of Minnesota's TMDLs came out in 2008 with a total of 1,475 impairments on 336 rivers and 510 lakes. A significant decrease occurred between this latest list and the 2006 TMDL list, which recorded 2,250 impairments on 284 rivers and 1,013 lakes. The major reason for the dramatic change was the approval of the statewide Mercury TMDL by the U.S. Environmental Protection Agency (mercury impairments made up two-thirds of the 2004 TMDL list). A second part of the 2008 TMDL List is an Inventory of all impaired waters that contains a total of 2,575 impairments including the approved Statewide Mercury TMDL and Southeast Regional Fecal Coliform TMDL. According to MPCA, "waters in the Inventory of impaired waters will remain there until they meet water quality standards."

The Minnesota River Basin has 336 impaired waters on the 2008 TMDL list and 546 on the Inventory of impaired waters. Pollutants or stressors for the basin include: fecal coliform bacteria, turbidity, chloride, mercury, fish bioassessments, dissolved oxygen, ammonia, PCB, Acetochlor and Nutrient/Eutrophication.

Impaired Waters
TMDL List in the Minnesota River Basin



The Impaired Waters graph (above) shows the number of impaired waters that have been placed on the Impaired Waters (303(d) List. The increase is largely a reflection of more waters being assessed.

Clean Water Act

Originally passed in 1972, the Federal Clean Water Act established the basic structure for regulating discharge of pollutants into the waters of the United States. It requires all states to adopt water standards that protect the nation's waters. One of its most important functions is to spell out requirements on setting water quality standards for all contaminants in surface waters. These standards define how much of a pollutant can be in a surface and/or ground water while still allowing it to meet its designed uses – drinking water, fishing, swimming, irrigation or industrial purposes.

The Clean Water Act requires each state to do the following:

- Assign designated uses to waters and develop standards to protect those uses,
- Monitor and assess their waters,
- List waters that do not meet standards,
- Identify pollutant sources and reductions needed to achieve standards,
- Develop a plan to implement restoration activities.

Lakes: Water Quality

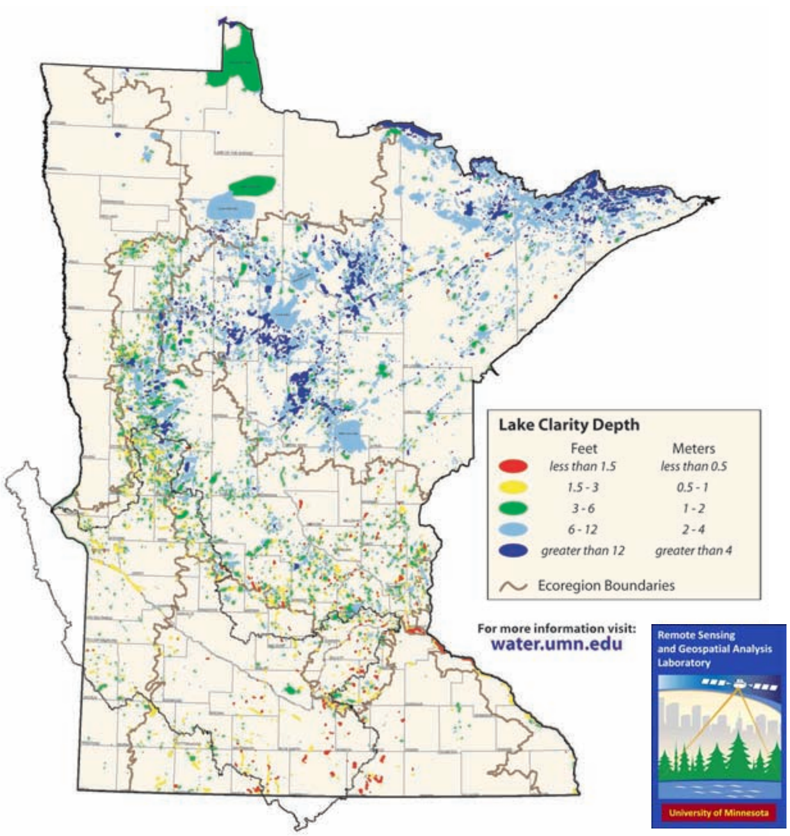
Lakes studies show mixed trends

The Long View: Diatom Reconstruction of Lake Sediments

A study of fossilized single-celled organisms called diatoms was revealing about the history of Minnesota's lakes. MPCA and Science Museum of Minnesota scientists (Heiskary and Swain) collected sediment cores from 55 Minnesota lakes. They examined diatom communities and estimated the amount of phosphorus in each lake over time by identifying sediment layers from around 1750, 1800, 1970, and 1993. They discovered that most of the lakes they examined in Minnesota's cities and agricultural areas showed serious eutrophication (see box below) since European settlement. But they found no change in lakes studied in forested northern Minnesota.

Decreasing lake water clarity in southern Minnesota

A University of Minnesota study examined lake water clarity using satellite data from 1985-2005. Researchers found strong geographic patterns in Minnesota: lakes in the south and southwest have low clarity, and lakes in the north and northeast tend to have the highest clarity. Over the 20 year period, researchers found mean lake water clarity in central and northern Minnesota stable while decreasing water clarity trends were detected in southern Minnesota (Western Corn Belt Plains and Northern Glaciated Plains ecoregions) (Olmanson et al 2008).



Matt Niebuhr

Lake Minnewaska, Chippewa River Watershed

"From the time they were created at the end of the Ice Age 10,000 years ago, Minnesota's lakes have been aging—slowly filling with sediment and increasing in fertility, with more plants, more plankton, less clarity."
Paula West
Minnesota Lakes Association (DNR, 2003)

"People seem to realize the state of our lakes is changing," said Paula West, executive director of the Minnesota Lakes Association. "More weed growth, more boat traffic, and there's more development—their experience isn't what it used to be." Older residents "are concerned that their children and grandchildren won't be able to have the same experience that they did," West said.

"From the time they were created at the end of the Ice Age 10,000 years ago, Minnesota's lakes have been aging—slowly filling with sediment and increasing in fertility, with more plants, more plankton, less clarity. But human influence on land can kick this aging, or eutrophication, into high gear. Leaky septic systems, agricultural runoff, and storm-water runoff contribute nutrients to surface waters, fertilizing algae blooms and turning lakes green and cloudy. Phosphorus plays a particularly big role in fertilizing lakes" (DNR, 2003).

What is Eutrophic?

A eutrophic body of water, commonly a lake or pond, that has high primary productivity caused by excessive nutrients and is subject to algal blooms resulting in poor water quality. The bottom waters of such bodies are commonly deficient in dissolved oxygen which can be detrimental to aquatic organisms.

Lakes: Water Quality continued

Statewide Lake Monitoring—Secchi Disk Readings Show No Overall Patterns

Lake monitoring records indicate not all lakes are deteriorating measurably. "There are no overall patterns," said Steve Heiskary, Minnesota Pollution Control Agency lakes research scientist. Heiskary has compiled Secchi disk readings (a measure of clarity based on the visibility of a white disk submerged in the water) from the MPCA's Citizen Lake Monitoring Program (CLMP) on more than 800 lakes in Minnesota. "If we look at a hundred lakes for these kinds of trends," he said, "we'll find perhaps 70 percent with no trends at all" (DNR 2003).

Statewide Comparison of Lake Water Quality

Parameter	Northern Lakes and Forests	North Central Hardwood Forests	Western Corn Belt Plains	Northern Glaciated Plains
Total Phosphorus (ug/l)	14 - 27	23 - 50	65 - 150	130 - 250
Chlorophyll mean (ug/l)	4 - 10	5 - 22	30 - 80	30 - 55
Chlorophyll max (ug/l)	< 15	7 - 37	60 - 140	40 - 90
Secchi Disk (feet) (meters)	8 - 15 (2.4 - 4.6)	4.9 - 10.5 (1.5 - 3.2)	1.6 - 3.3 (0.5 - 1.0)	1.0 - 3.3 (0.3 - 1.0)
Total Kjeldahl Nitrogen (mg/l)	0.4 – 0.75	< 0.60 - 1.2	1.3 - 2.7	1.8 - 2.3
Nitrite + Nitrate-N (mg/l)	<0.01	<0.01	0.01 - 0.02	0.01 - 0.1
Alkalinity (mg/l)	40 – 140	75 - 150	125 - 165	160 - 260
Color (Pt-Co Units)	10 – 35	10 - 20	15 - 25	20 - 30
pH (SU)	7.2 - 8.3	8.6 - 8.8	8.2 - 9.0	8.3 - 8.6
Chloride (mg/l)	0.6 – 1.2	4 - 10	13 - 22	11 - 18
Total Sus. Solids (mg/l)	< 1 – 2	2 - 6	7 - 18	10 - 30
Total Sus. Inorganic Solids (mg/l)	< 1 – 2	1 - 2	3 - 9	5 - 15
Turbidity (NTU)	< 2	1 - 2	3 - 8	6 - 17
Conductivity (umhos/cm)	50 – 250	300 - 400	300 - 650	640 - 900
TN:TP ratio	25:1 - 35:1	25:1 - 35:1	17:1 - 27:1	7:1 - 18:1

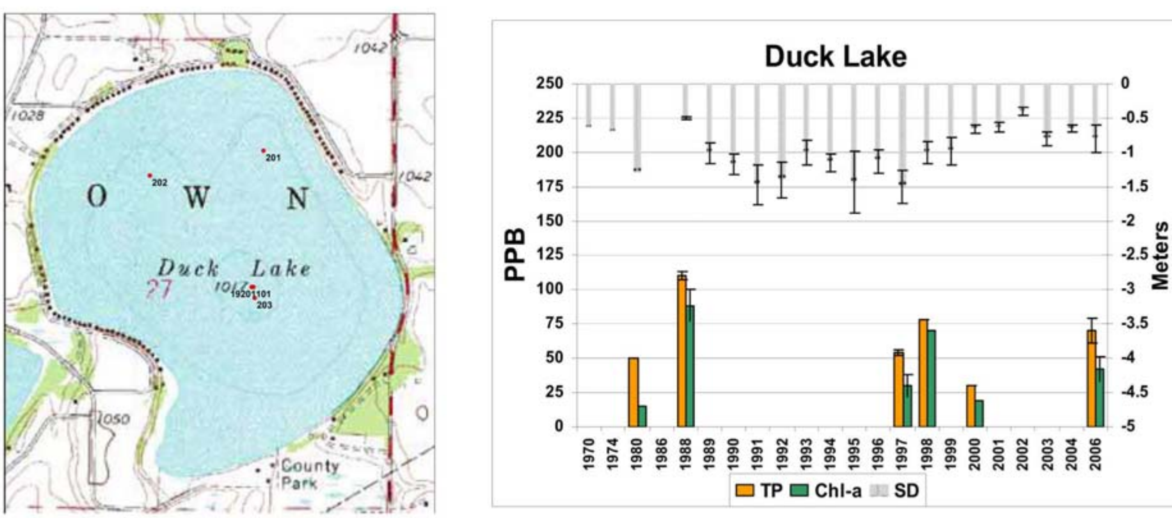
The Minnesota River Basin lies predominantly in the Western Corn Belt Plains (WCBP) and Northern Glaciated Plains (NGP) ecoregions. The chart above illustrates the different characteristics of this part of the state. Note the generally higher TP, chorophyll, Nitrates, TSS, and turbidity in these regions (MPCA, 2003).

Shallow Lakes—Nutrient Rich

A MPCA Study of Shallow Lakes of Southwestern Minnesota concluded: Most of the lakes are very nutrient rich. The high Total Phosphorus (TP) concentrations contribute to high chlorophyll-a, which is expressed as nuisance blooms of algae. Many of the lakes are dominated by blue-green algae that float near the surface and contribute to perceptions of "swimming impairment' or "no swimming." All lakes have highly agricultural watersheds, which is typical for lakes in these two regions. Agriculturally- dominated watersheds have higher P export values (expressed as stream TP) than watersheds characterized by forested and wetland land uses. Most of the lakes in this study did not have adequate data to assess trends. CLMP data, which is often a primary database for assessing trends in Minnesota lakes, are spotty or absent for most of the lakes. However, based on modern-day data (used in this report) and diatom-inferred data (Heiskary and Swain, 2002) no region-wide statements regarding trends can be made for the Western Corn Belt Plains (WCBP) and Northern Glaciated Plains (NGP) ecoregions.

Blue Earth County Lake Study—Mixed Trends

Figure 29. Duck Summer Mean Water Quality Trend and Sampling Locations



A MPCA study examined 6 lakes in Blue Earth County and found mixed trends. The example above shows Duck Lake, a small lake in Blue Earth County. It showed a significant decrease in transparency from 1997-2002. Total Phosphorus (TP) and chlorophyll-a are variable and show no consistent trends (MPCA, 2006).

Lakes: Water Quality continued

Toxic Blue Green Algae—When in Doubt, Stay Out

Eileen Campbell

Toxic Blue Green Algal bloom
Crystal Lake, MN

Katie Brosch

Blue Green Algal bloom
Bass Lake, MN

Most algae are harmless but in high concentrations, a type of algae called "blue-green" (cyanobacteria) algae can be toxic. People or animals who contact toxic blue-green algae blooms can become sick. In recent years Minnesota has had increased reports and documentation of harmful algal blooms (HAB). People or animals may develop skin irritation or upper respiratory problems from exposure to HAB, and in extreme cases, dogs and other animals have even died after drinking lake water containing these toxins.

Blue green blooms typically occur on lakes with poor water quality (high in nutrients), and are often described to look like green paint, pea soup, or a thick green cake. A combination of factors will typically cause an algae bloom. Excessive nutrients, still waters, warm temperatures, and lots of sunlight all encourage the growth of blue-green algae. Recently Minnesota has done several studies and outreach efforts to better understand the risk of HAB and to improve public awareness. http://www.pca.state.mn.us/water/clmp-toxicalgae.html Unfortunately, there is no visual way to assess the toxicity of an algae bloom. Protect yourself and animals by staying away from dense algal blooms. When in doubt stay out!

Pesticides in Lakes

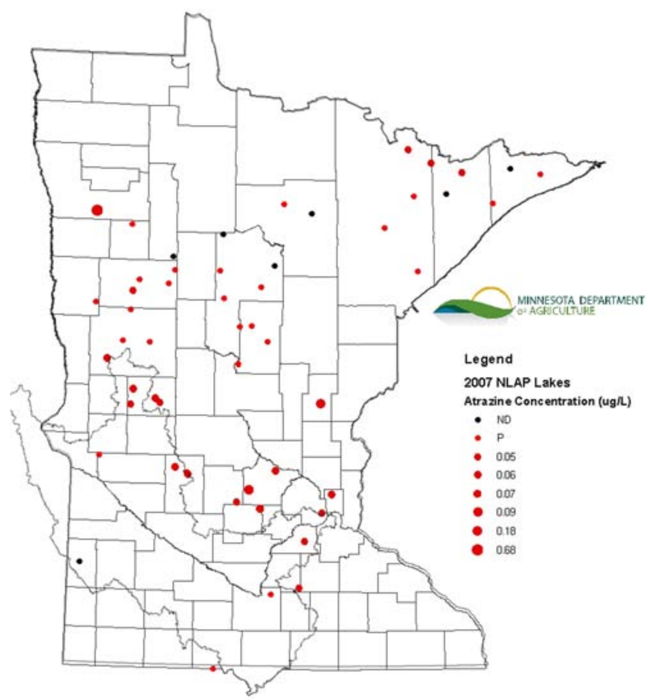
The Minnesota Department of Agriculture monitors for pesticides in lakes across the state. The MDA sampled 53 lakes for the 2007 Pesticides in Minnesota Lakes Study. Key findings include:

- **Pesticides Detected in Most Lakes:** A pesticide or a pesticide degradate was detected in 91 percent of the samples collected from Minnesota lakes. Concentrations of all detected pesticides were well below the Minnesota aquatic life standards and other reference values used by the Minnesota Department of Agriculture.

- **Atrazine** was detected in 87 percent of the 53 sampled lakes in Minnesota including lakes far from areas of assumed atrazine application. The concentration of atrazine was higher in samples collected from rivers then those measured in lakes located in the same Pesticide Monitoring Regions (PMR). Atmospheric deposition is suspected as the primary method of transport in lakes where pesticides, primarily atrazine, are detected far from areas of application. The degradate detected at the greatest frequency was deethyl atrazine a breakdown product of atrazine. Other pesticide degradates were found less frequently but at higher concentrations.

- **Agricultural Watersheds:** Lakes in lakesheds with row crop agriculture as a dominant land use had higher concentrations of total pesticides. This may be the result of direct runoff from adjacent lands or from greater atmospheric deposition due to closer proximity to areas of application. Lakes within lakesheds dominated by cultivated agriculture had substantially higher total pesticide concentrations than lakes within lakesheds dominated by urban and forest/water land use (MDA, 2008).

Pesticides Detected in Lakes: Atrazine in 2007



Fifty-five pesticide samples were collected from lakes throughout Minnesota in 2007. The map above shows Atrazine concentrations in lakes (MDA, 2008).

Ground Water: Quantity

Moderate to limited availability

Researchers are still learning about the extent of ground water supplies in the state. The Minnesota Department of Natural Resources (MDNR) is the primary state agency responsible for managing the quantity of Minnesota's ground and surface waters. The MDNR maps aquifers and issues water-use permits to balance competing demands and to protect natural resources.

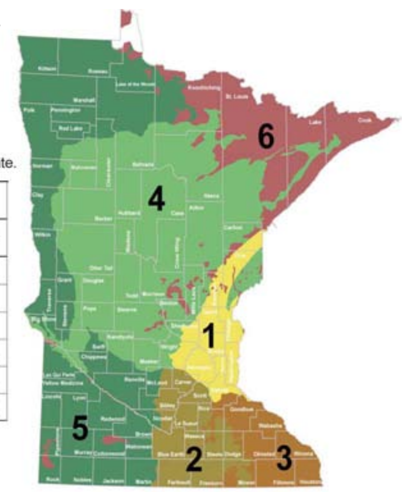
Ground Water Availability

MDNR's map of ground water availability shows that Minnesota's ground water resources are not evenly distributed. Ground water in the Minnesota River Basin is illustrated primarily within areas "5" and "2" on the map at right. Ground water of adequate quality for drinking and other desired uses has always been scarce in southwest (and northwest) Minnesota because of the natural geologic and hydrologic conditions in these areas. To overcome the problem of finding water of adequate quality and quantity for drinking and other needs, rural water systems have been constructed in some communities in the southwest. (MDNR, 2005 map, MPCA 2007).

Minnesota's Ground Water Provinces

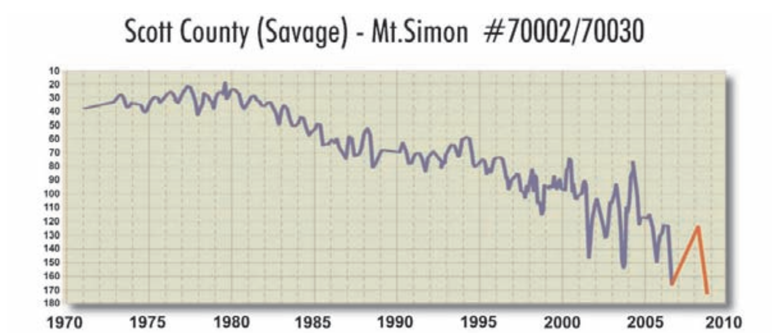
TABLE 1. Ground-water availability in the state.

Area	General Availability of Ground Water by Source: Surficial Sands	Buried Sands	Bedrock
1	Moderate	Moderate	Good
2	Limited	Moderate	Good
3	Limited	Limited	Good
4	Good	Moderate	Limited
5	Moderate	Limited	Limited
6	Limited	Limited	Limited



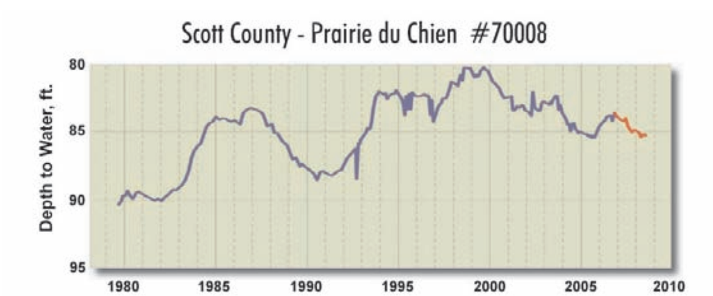
Source: MDNR 2005

The MDNR is the agency responsible for ground water level monitoring. The extent of ground water supply is not well understood and is currently being studied. Jim Sehl, MDNR's ground water specialist in southern Minnesota stated that "in many cases, there's considerable uncertainty about how much water is available underground." Ground water level monitoring began in 1942 and now consists of a network of 750 observation wells across the state. Data from these wells is used to determine many issues including the impact of pumping and climate and to assess long term trends. There is a diversity of results depending on the aquifer type (unconfined, confined) location, and use. A couple examples from observation wells within the Minnesota River Basin provide some insight into ground water trends.



Mt. Simon Aquifer (confined)

Results from the southern Metro observation well in Scott County near Savage showed water levels in 2008 the lowest ever measured and continues a downward trend in water levels that began in 1980. MDNR attributes this long term decline partly to climate and partly to pressures exerted on this aquifer from development in the area (MDNR, 2009).



Jordan and Prairie du Chien Aquifers (confined bedrock)

The Jordan and Prairie du Chien aquifers are bedrock aquifers (see map next page). The observation well in Scott County Prairie du Chien aquifer (above) has varied water levels from 1980 to present. The water levels have decreased since the levels observed in 2006 but the same decrease is not observed for the same aquifer in neighboring Rice and Hennepin county observation wells,

What is an Aquifer?

An aquifer is a body of rock or sediment that stores and transmits large amounts of ground water. An aquifer typically consists of sands and gravels with interconnected pore spaces or rocks with numerous interconnected fractures or cavities. Aquifers may be unconfined or confined.

Confined Aquifer–These aquifers are separated from the ground surface by a material of low permeability. Confined aquifers include buried drift and bedrock aquifers.

Unconfined Aquifer–In Minnesota, unconfined aquifers are typically composed of glacial sand and gravel. These aquifers have the water table exposed to the atmosphere. They are also called water table or surficial aquifers.

Ground Water: Water Quality

Nitrates and Arsenic are pollutants of concern

Ground Water Timeline

1960s
In the early 1960s the Minnesota Geological Survey (MGS) began to investigate Minnesota's bedrock aquifers, beginning with aquifers in urban areas.

1972
The MGS published a comprehensive survey on the geology of Minnesota that noted "reliable data on the … aerial extent of bedrock aquifers are generally only available for the major urban centers. However, even in the urban areas, specific information on the physical and chemical environments of the geologic units generally is poorly known."

1978
MPCA and USGS develop a ground water monitoring plan

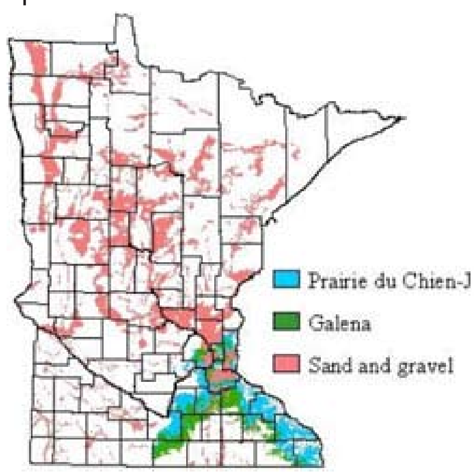
1989 Minnesota's Ground Water Protection Act
By the mid-1980s the presence of ground water contamination around the sate and its considerable impact on those affected was becoming well known. This protection act was triggered by severe drought in 1988.

1992-1996
MPCA collected ground water samples from domestic water supply wells from most Minnesota counties.

1998
Baseline Study published by MPCA provided information about ambient ground water quality in Minnesota's principal aquifers.

The Minnesota Pollution Control Agency (MPCA), Minnesota Department of Agriculture (MDA), and Minnesota Department of Health (MDH) each have important statutory responsibilities in protecting the quality of Minnesota's ground water, but only the MPCA and the MDA conduct statewide ambient ground water quality monitoring. The MDH conducts ground water monitoring in order to regulate public and private water supply wells and public water supplies, and evaluate the risk to human health from contaminants in ground water.

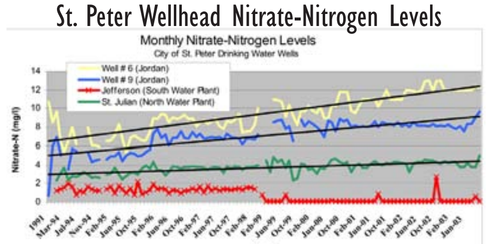
Aquifers Vulnerable to Pollution



Source: MPCA 2006

In Minnesota, geology largely dictates aquifers that are vulnerable to pollution. Aquifers that meet the designation of "vulnerable" include water table or unconfined aquifers, and the Prairie du Chien, Jordan and Galena bedrock aquifers at locations where there is no significant protective soil cover overlying the bedrock. The water table aquifers are typically composed of unconsolidated sand and gravel that was deposited by glacial activity in recent geologic time; these near surface aquifers occur throughout the state. The Prairie du Chien, Jordan, and Galena bedrock aquifers are considered vulnerable primarily in the Twin Cities and southeast Minnesota, where they outcrop at or near the ground surface.

St. Peter Wellhead Nitrate-Nitrogen Levels



Major Pollutants: Nitrates & Arsenic

Major ground water pollutants of concern in the basin include nitrates and arsenic. Nitrate is a common contaminant found in many wells throughout Minnesota. Wells most vulnerable to nitrate contamination include shallow wells, dug wells, and wells with damaged or leaking casings. Major sources of nitrate contamination can be from fertilizers, animal waste, and human sewage. Arsenic occurs naturally in some soil and rock and can leach into groundwater. Almost all arsenic in drinking water is from underground deposits of naturally occurring arsenic. Statewide arsenic sampling in Minnesota indicates that a significant area of the state has detectable concentrations of arsenic in ground water (MCPA, 1995), Approximately 14% of sampled wells exceeding the arsenic standard of 10 μg/l., Arsenic is particularly concentrated in western Minnesota where over 50% of the 900 sampled private drinking water wells had arsenic over 10 μg/l (MDA, 2001).

Municipal Systems - MDH

Municipal systems are monitored closely by MDH to meet health standards. Their source water protection program is designed to help prevent contaminants from entering public water sources. The program includes wellhead protection (capture zone for the well), source water assessments (description of water source), and where needed protection of surface water intakes.

St. Peter Wellhead Protection Program
States are required to have wellhead protection programs under the provisions of the 1986 amendments to the federal Safe Drinking Water Act. A case study example includes the St. Peter Wellhead Protection Program where nitrate is the primary contaminant of concern. The graph (at left) shows nitrate concentrations steadily increasing from 1991-2003. The city blends water from different wells to stay within public health guidelines (BNC, 2003).

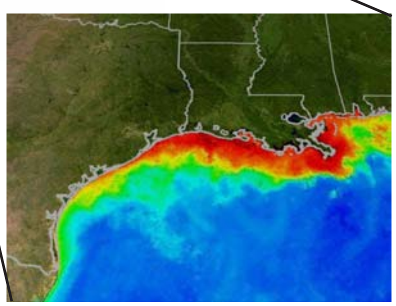
Downstream Impacts: Nitrates & The Dead Zone

A substantial contributor of excess nitrate

The Minnesota River and the Dead Zone

As the Minnesota River flows into the Mississippi River, it carries excess sediment and nutrients which impact downstream receiving waters.

The Minnesota River has been identified as a substantial contributor of excess nitrate to the Mississippi River and the Gulf Region.



NASA Visible Earth Program
Image from 2004

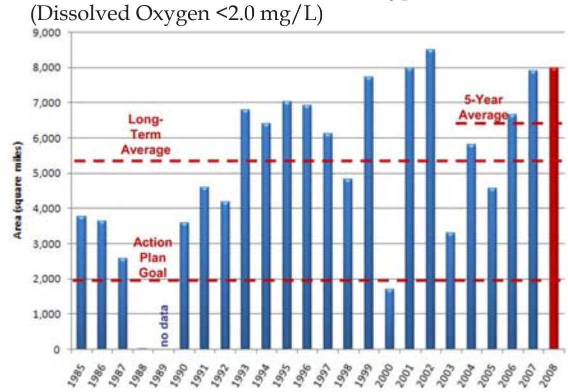
In 2008, the Dead Zone in the Gulf of Mexico stretched 7,988 square miles measuring second largest since measurements began in 1985. Source: NOAA, 2008

Science Museum of Minnesota

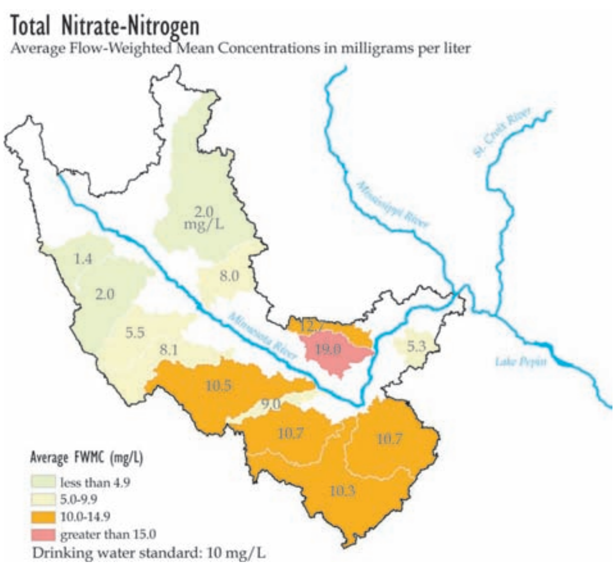
Gulf of Mexico algal blooms

Size of the Gulf of Mexico Dead Zone

Area of Mid-Summer Bottom Water Hypoxia
(Dissolved Oxygen <2.0 mg/L)



The size of the Gulf of Mexico Dead Zone is increasing. The average size of the Dead Zone over the past 5 years has been 6,600 square miles. The long term average is 5,300 square miles (NOAA, 2008).



This map shows the average flow-weighted mean concentrations of Nitrate-Nitrogen across the Minnesota River Basin 2000-2005. Elevated Nitrate levels can stimulate excessive levels of algal growth in streams.

Met Council

Algal blooms and dead fish

What is the Dead Zone?

In recent years, this problem has been particularly severe in the Gulf of Mexico where development of a hypoxic zone (hypoxia means "low oxygen") has been linked to elevated nitrate levels carried to the Gulf by the Mississippi River. Reduced oxygen levels in the hypoxic zone, brought on by decomposition of algae, have damaged the shellfish industry and continue to threaten the aquatic ecosystem of the Gulf Region.

Downstream Impacts: Sediment, Phosphorus & Lake Pepin

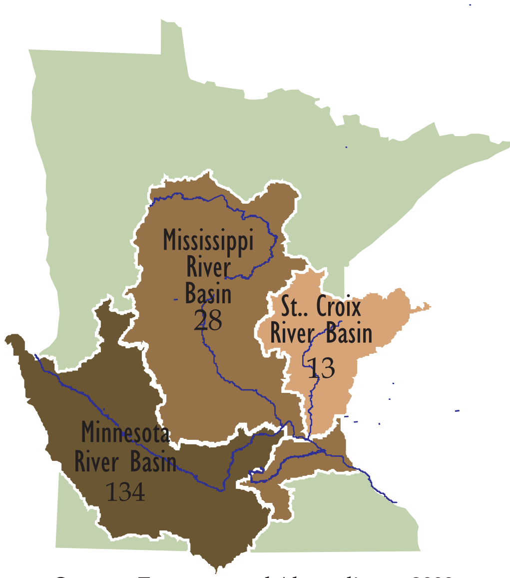
Lake Pepin is filling in with sediment at about 10 times its natural rate. At this rate, it will be completely filled with sediment within 340 years.

Lake Pepin lies downstream of the confluence of the Minnesota and Mississippi Rivers. It is a naturally occurring lake, and part of the Mississippi River on the border between Minnesota and Wisconsin.

Lake Pepin is filling in

As the Minnesota River flows into the Mississippi, it carries excess sediment and nutrients. Three rivers contribute sediment to Lake Pepin: The Minnesota, St. Croix, and Mississippi Rivers. Scientists have studied sources of sediment into the lake and determined that the Minnesota River contributes approximately 85 percent of the sediment load.

Total Suspended Sediment Yield
(Pounds per acre, per year)



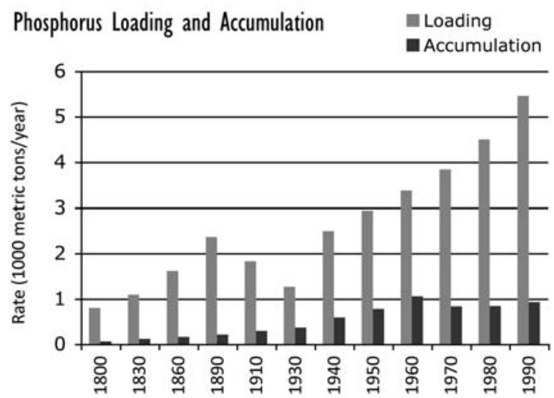
Sources: Engstrom and Almendinger, 2000
Nater and Kelley, 1998

Elevated Phosphorus Levels


Met Council

Lake Pepin

Phosphorus is accumulating in the sediment at 15 times the natural rate. Phosphorus loading to the lake appears to have increased by about seven times (or more) above natural rates. Lake water Total Phosphorus concentrations have increased from about 50 ppb (parts per billion) to 200 ppb, making Lake Pepin highly eutrophic. Eutrophic means waters rich in mineral and organic nutrients promote a proliferation of plant life, especially algae (see photo below), which reduces the dissolved oxygen content and can cause fish kills.

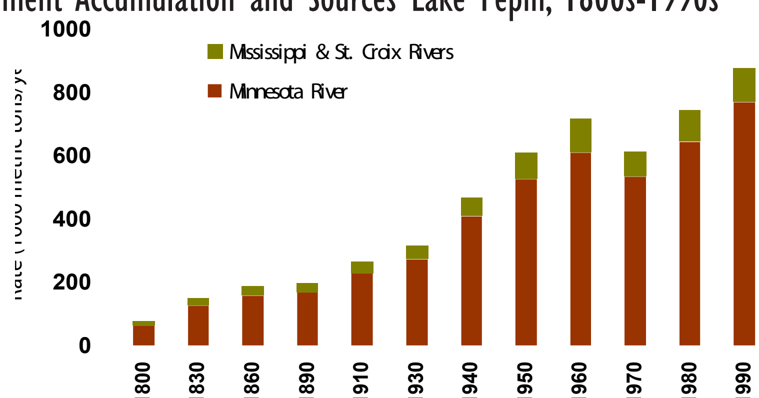


Total phosphorus loading and accumulation from 1800 to 1990.
Source: Engstrom and Almendinger, 2000


Met Council

Excess phosphorus concentrations can lead to algal blooms in Lake Pepin.

Sediment Accumulation and Sources Lake Pepin, 1800s-1990s

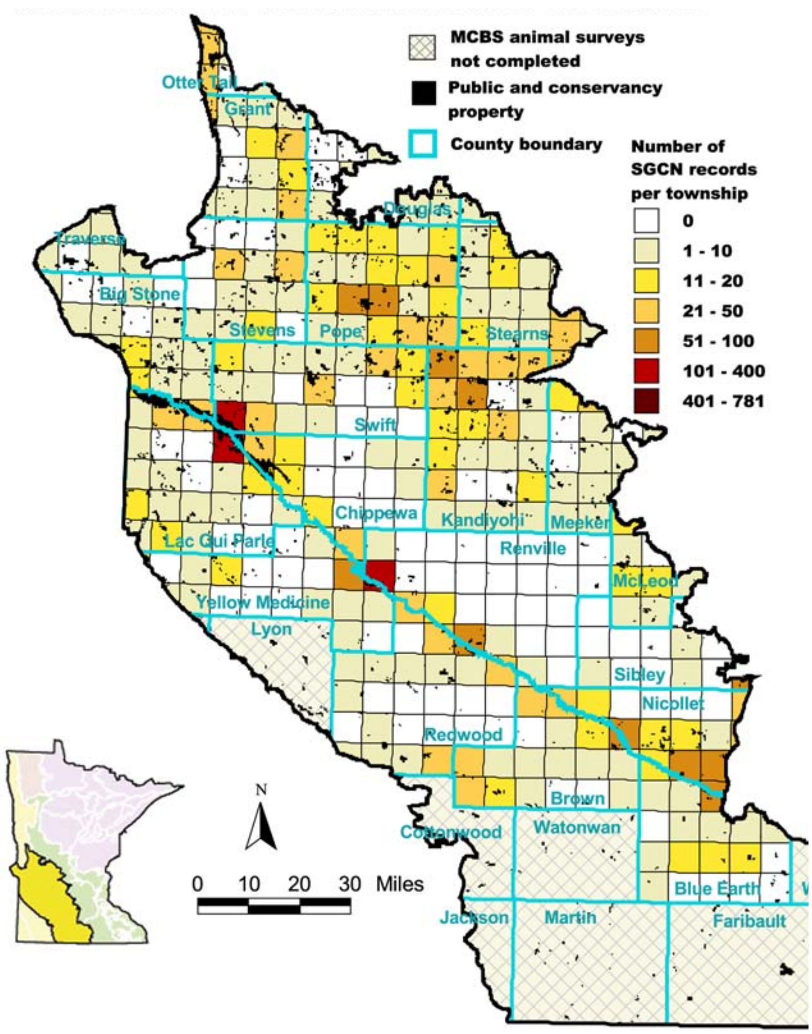


Sources: Kent Johnson, Metropolitan Council, 2000 & Engstrom and Almendinger, 2000

Overview Living Resources

Many diverse plant and animal communities occur within the basin. Out of the many possible indicators, an interagency team of researchers brainstormed the list of species explored here to provide some insight into broader ecosystem health. They can be organized into those primarily living in aquatic habitats (macroinvertebrates, mussels, frogs, fish, river otters) and terrestrial habitats (bald eagles, ring-necked pheasants, and ducks).

Species of Greatest Conservation Need Occurrences by Township since 1990



The map above shows the number of validated records of species in greatest conservation need since 1990 per township and public land/conservancy land. Townships in red and orange colors indicate areas with more species of greatest conservation need (SGCN) observations. Hatchmark areas display areas that have not been surveyed for rare animals by Minnesota County Biological Survey (DNR, 2006).

This DNR map from *Tomorrow's Habitat for the Wild and Rare: An Action Plan for Minnesota Wildlife*. depicts the distribution of rare species throughout the prairie portion of the Minnesota River Basin (see inset map). The Minnesota River Valley and lake-rich townships are conspicuous indicating the importance of these water resources and related habitats for rare species.

Rare Species in the Prairie Region

Once widespread, prairie remnants and floodplain forests are now rare. Still, the remaining wetlands and grasslands offer prime habitat for bald eagles, prairie chickens, marbled godwits, upland sandpipers, Richardson's ground squirrels, regal fritillaries, swainson's hawks, Forster's terns, and dickcissels. The dry grasslands provide habitat for bullsnakes and western hognose snakes, and foxsnakes occur in upland riparian forests. The area is a major migratory corridor in the Mississippi Flyway and an important nesting area for prairie ducks. Portions of the Minnesota River and/or tributaries provide habitat for paddlefish, mussels, and softshell turtles as well as the threatened mucket and elktoe mussels (DNR, 2006).

What are Some Factors Leading to Rare Species Decline?

Habitat Loss in Minnesota
Habitat Degradation in Minnesota
Habitat Loss/Degradation Outside Minnesota
Invasive Species and Competition
Pollution
Disease
Food Source Limitations

Macroinvertebrates

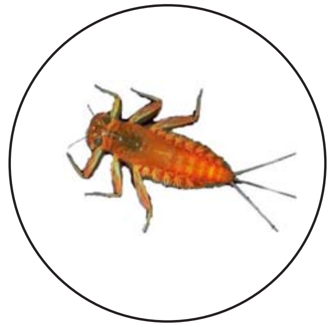
Biological indicators of stream health show mixed trends

Scott Kudelka

Paul Wymar from the Chippewa River Watershed Project collecting macroinvertebrates

Scott Matteson

Macroinvertebrates on underside of rock.



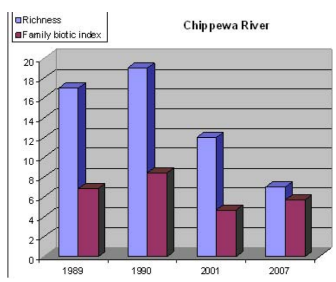
Macroinvertebrate: *Heptageneidae*
Photo: North American Benthological Society

Chippewa River Watershed

What are Macroinvertebrates?

Macroinvertebrates are animals without backbones that can be seen with the naked eye and live at least part of their life cycles in or on the bottom of a waterbody. Macroinvertebrates (macros) include aquatic insects like mayflies, stoneflies, caddisflies, midges, and beetles as well as crayfish, worms, mussels and snails. They spend most or all of their life cycle in water and inhabit all types of moving water from rushing mountain streams with rocky bottoms to sluggish, meandering streams with sand and mud bottoms. A community is classified as different types of macroinvertebrates living in the same habitat areas in a river.

Macroinvertebrate Collection



Macroinvertebrate communities and family richness can be affected by a number of factors including pollution along with changes in habitat and substrate. A decline of macroinvertebrate diversity and numbers in the Chippewa River could have been a result of major flooding in 1997 and lesser flooding in 2001. Deposition of silt and clay most likely has also impacted them in non-flood years. Macroinvertebrate sampling has been conducted in the Chippewa River Watershed by MPCA and the Chippewa River Watershed Project. Methods for sampling has evolved and changed over the years with no consistent protocol. Currently, no state standard has been set for sampling macroinvertebrates.

MN River Assessment Project Report

Published in January of 1994, this report offered the following findings on macroinvertebrate sampling in the basin:

- Macroinvertebrate communities were assessed at approximately 40 sites along the main stem of the MN River, its tributaries, and small-watershed streams. Most sites sampled had been adversely affected by pollution, and had fewer species than would be desirable.
- All macroinvertebrate communities at the sites studied on the main stem were judged as moderately to severely affected by pollution. Main stem sites at Henderson and Lac qui Parle were the most severely affected.
- Macroinvertebrate communities in the larger tributaries were considered moderately affected by pollution. Chippewa River was the most affected tributary.
- For the small to intermediate streams, physical characteristics and composition of bottom-dwelling communities varied greatly. Most of these sites are moderately affected and some severely affected by pollution.
- Habitat modification and excessive amounts of organic material were factors affecting macroinvertebrate communities.

Macroinvertebrates as Indicators

- Represent important links in the food chain as recyclers of nutrients and food for fish.
- Cannot swim from pollution like fish and can be affected by even subtle levels of pollution, showing the effects of both short- and long-term pollution events.
- Some are intolerant and others tolerant of pollution. Taken together, the presence or absence of tolerant and intolerant types can indicate the waterbodies' overall health.
- Because each has a different tolerance to pollution any alteration to a river may have an impact on their abundance and distribution and may show the cumulative impacts of pollution.
- They have short life cycles – usually one season or less in length – meaning a water quality problem could be detected quicker.
- May show the impacts from habitat loss not detected by traditional water quality assessments.
- Relatively easy to sample and identify to a level that provides meaningful information about a stream's health.

Mussels — Canaries of Water Quality

Despite declines in historic diversity, mussels now show static trends

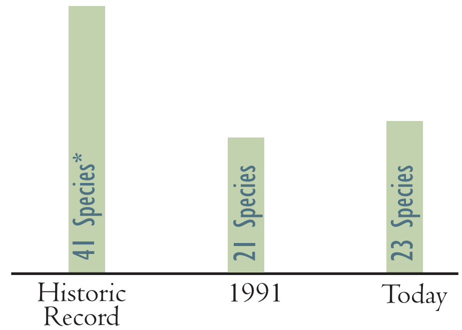

Scott Kudelka


Scott Kudelka

The presence or absence of mussels is a biological indicator of a river's health. This freshwater organism can be found in rivers and lakes on every continent except Antarctica. As a member of the second largest group of animals in the world—the Mollusks, mussels spend their entire life partially or wholly buried in mud, sand or gravel in permanent bodies of water. Of the almost 300 species found in North America (more than any other continent), 48 are considered native to Minnesota. Unfortunately, 25 of those species are listed as endangered, threatened, or of special concern, and two believed to be extirpated. Today only 23 can be found, some of which are critically imperiled in the system.

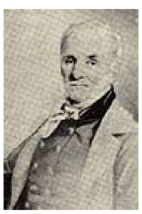

Scott Kudelka

Number of Mussel Species in the Minnesota River Basin



* 40 species are confirmed with a historic record of scaleshell. There is an unresolved discovery of a Quadrula species.

Historic Account


Wisconsin Electronic Reader

George Featherstonhaugh was an Englishman who explored the Minnesota River from Fort Snelling to Lake Traverse in 1835.

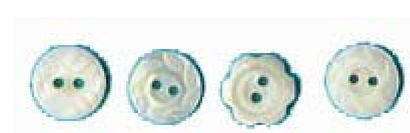
Canoeing from the Blue Earth River confluence to Granite Falls, he remarked on a "great profusion of unios [mussels] lying on the sandy bottom."

Downstream from the Redwood River confluence, "We found the river diminish from two feet and a half to one foot, the water beautifully transparent, and the unios [mussels] stuck in countless numbers in the pure white sand, so that I could, by baring my arm, select them as we went along."

Did You Know? Mussels from Minnesota River for Buttons

Brown County Historical Society

In the late 1800s and early 1900s enormous numbers of freshwater mussels were harvested for button-making to make pearl buttons for clothing. This became a multi-million dollar business. New Ulm was a center for this industry in the Minnesota River. All mussels are now protected and it is illegal to kill any mussels in Minnesota.



Timeline

1916
A crew of clammers arrived in Granite Falls to dig for mussels. They used boats with rakes between Montevideo and Mankato to gather 10 tons of shells worth $30,000 to ship to the button factories in Iowa.

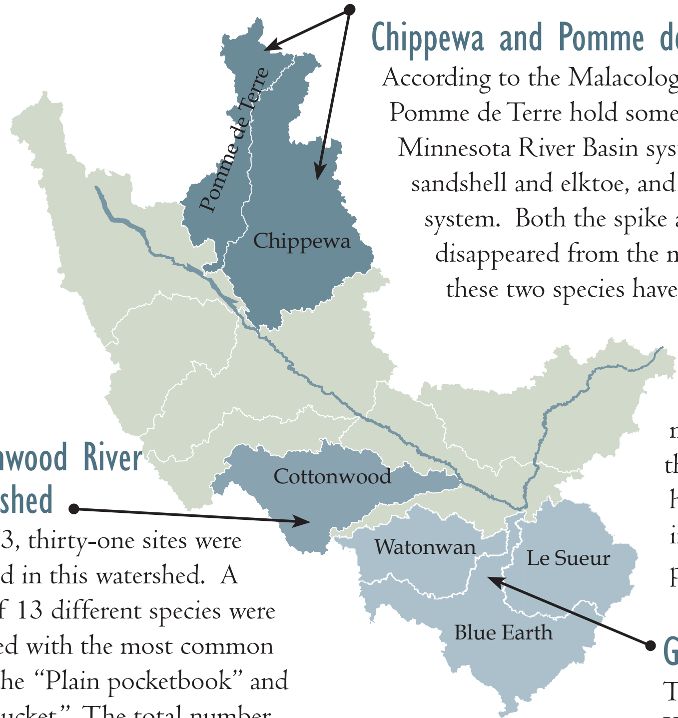
1917
The mussel harvest was a poor one with the beds worked over from the previous summer.

1921
Fourteen tons of shells were shipped from Granite Falls and 16 tons from Wegdahl to the Muscatine Button Factory.

1926
Minnesota Conservation Department banned clamming on the Minnesota River between the Yellow Medicine and Lac qui Parle rivers.

1933
Twenty to thirty men were hired by the Smith Brothers of Granite Falls to dig mussels with 80 tons of shells shipped to button factories. The meat from the mussels were boiled and sold for hog feed.

Today
No live mussels may be collected in Minnesota without a special permit.
Source: http://www.karipearls.com/pearl-buttons.html



Chippewa and Pomme de Terre River Watersheds

According to the Malacologist specialists with the MN DNR, the Chippewa and Pomme de Terre hold some of the best remaining mussel assemblages in the entire Minnesota River Basin system. This includes reproducing populations of black sandshell and elktoe, and the only remaining population of spike within the entire system. Both the spike and black sandshell (each listed as special concern) have disappeared from the main stem of the Minnesota River. Juvenile mussels of these two species have also been found – evidence they are reproducing in the Chippewa River. The Chippewa and Pomme de Terre rivers retain a majority of the mussel species historically found in the two watersheds, compared to most of the other tributaries that have lost up to half of their original mussel species. Today, mussel abundance is higher in these two rivers than any other major tributaries in the MN River Basin and also contains healthy populations of some common species.

Cottonwood River Watershed

In 2003, thirty-one sites were sampled in this watershed. A total of 13 different species were recorded with the most common being the "Plain pocketbook" and "Fat mucket." The total number of live mussels collected (within 58 hours of sampling) was 646. During a citizen summary of the Cottonwood, a Lilliput shell was found—the first time for the watershed.

Greater Blue Earth River Watershed

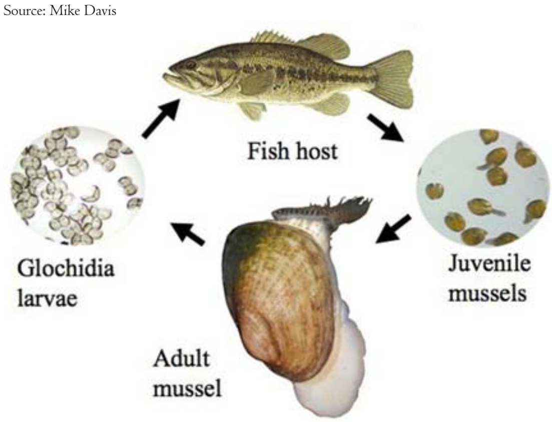
The Greater Blue Earth River Watershed (including the Watonwan and Le Sueur Rivers) is one of the largest watersheds in the Minnesota River Basin and one of the most degraded. As of 2009, DNR biologists found only 3 of the 24 historic mussel species after sampling 124 sites. Even some of the most common mussel species–fat mucket, three ridge and Wabash pigtoe–found in other areas of the Basin are rare or have disappeared from the Greater Blue Earth River system. Similarly, a survey of 138 sites in 1972 by Dale Chelbars of the Science Museum of Minnesota found only 134 live mussels from 11 species.

What is killing Mussels?

- Dredging,
- Chemical pollution,
- Sedimentation,
- Channelization,
- Wetland drainage,
- Overharvesting of mussels,
- Excessive tiling – causing rapid bounces in river levels,
- Dams - prevent fish migration,
- Industrial pollution,
- Competition from exotic species

Typical Mussel Reproduction Cycle

Source: Mike Davis



Scott Kudelka

"The Blue Earth River, including the Watonwan and Le Sueur rivers, is the largest tributary of the Minnesota River. Sadly, the mussel fauna of the Blue Earth is also among the most degraded."
Bernard Sietman, MDNR

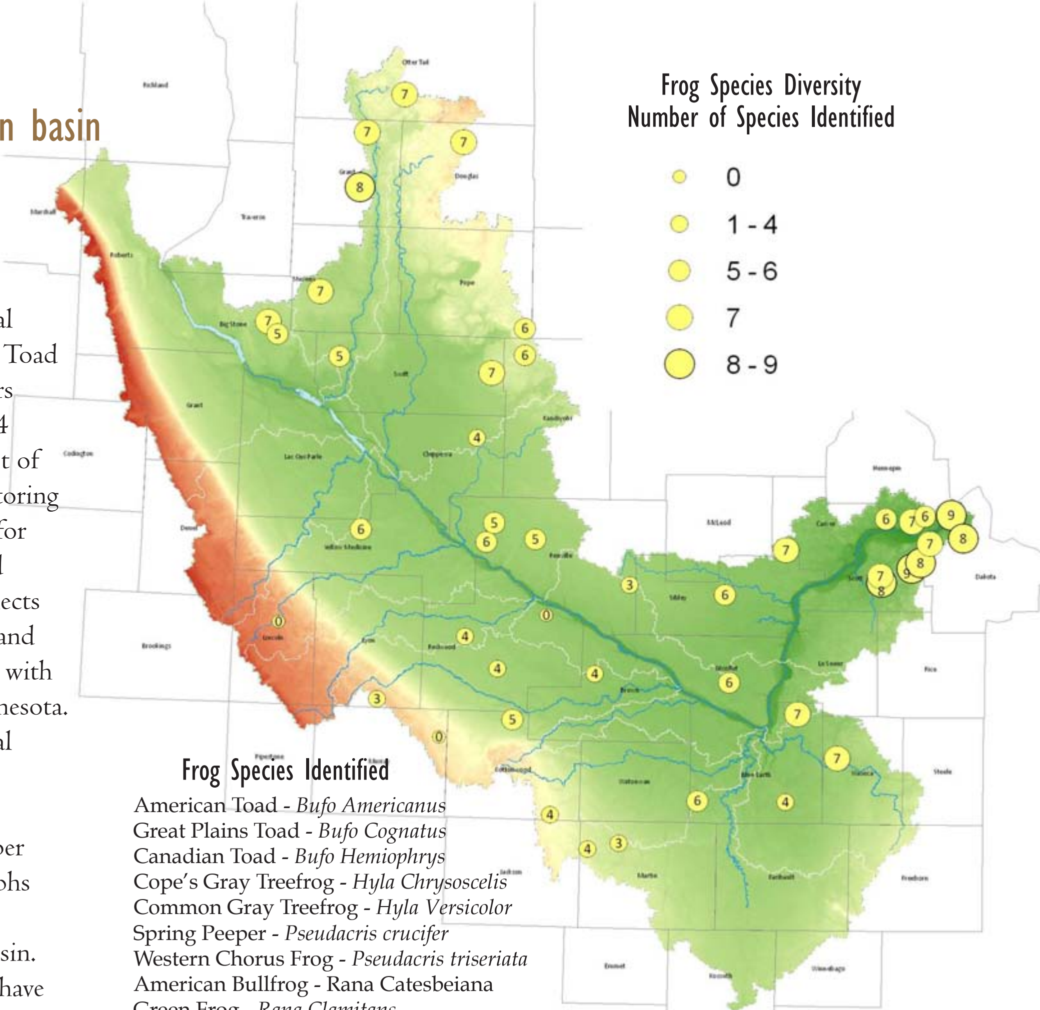
Frog Surveys

Frog abundance on the rise in basin

Minnesota Frog & Toad Calling Survey

The Minnesota Department of Natural Resources (DNR) initiated a Frog & Toad Calling Survey in 1996 to use volunteers across the state to collect data on the 14 different frog and toad species. It is part of the North American Amphibian Monitoring Program (NAAMP). Volunteers listen for the sound of each species on a specified 10-stop route. This on-going study collects data to increase the knowledge of frog and toad abundance and distribution, along with monitoring population changes in Minnesota. All the results are presented in an annual report.

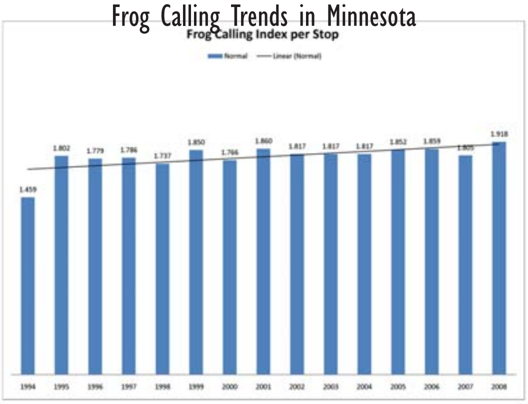
The map at right summarizes the number of species identified per route. The graphs below show the frog calling trends for Minnesota and the Minnesota River Basin. The Minnesota River Basin appears to have a stronger increasing trend in frog calling compared to the state.



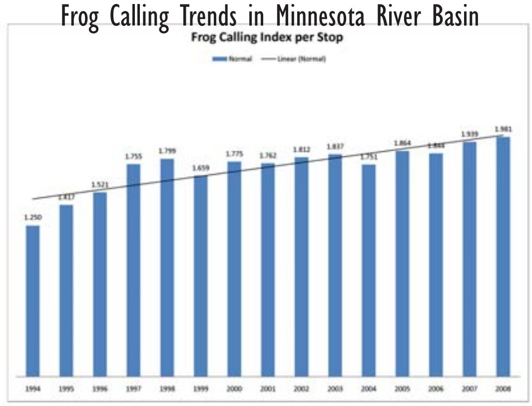
Frog Species Identified

American Toad - *Bufo Americanus*
Great Plains Toad - *Bufo Cognatus*
Canadian Toad - *Bufo Hemiophrys*
Cope's Gray Treefrog - *Hyla Chrysoscelis*
Common Gray Treefrog - *Hyla Versicolor*
Spring Peeper - *Pseudacris crucifer*
Western Chorus Frog - *Pseudacris triseriata*
American Bullfrog - Rana Catesbeiana
Green Frog - *Rana Clamitans*
Northern Leopard Frog - *Rana Pipien*s
Mink Frog - *Rana Septentrionalis*
Wood Frog - *Rana Sylvatica*

Frog Calling Trends in Minnesota



Frog Calling Trends in Minnesota River Basin



In the graphs above, all stops are combined for each year to get an average calling index for each year.

Researchers identify local amphibian species by their unique breeding vocalizations or calls. At each stop on their routes, the volunteer listens for 5 minutes, and then records the amphibian calling index for each species heard and some environmental data:

1 - Individuals can be counted; there is space between calls
2 - Calls of individuals can be distinguished but there is some overlapping of calls
3 - Full chorus, calls are constant, continuous and overlapping

The results of the NAAMP ongoing study will provide information on where species are located throughout the state, and how their population change in abundance and distribution. Many frog and toad species are indicators of habitat quality. Their presence in, or disappearance from, an area may provide information on the condition of Minnesota's wetland habitats.

Northern Leopard Frogs – “A sentinel”

Northern Leopard frogs show population decline

About Northern Leopard Frogs

One of the most common frogs in the Minnesota River Watershed, the Northern Leopard Frog, can be found throughout the state and identified by two or three rows of dark spots on the back or a snoring sound made with grunts and squeaks. Northern Leopard Frogs live in a wide variety of habitats including wet meadows, open fields and grasslands near waterbodies, wetlands and forest edges. These frogs may move up to two miles from a water source in the summer.

Frogs begin their lives as eggs floating on the surface of still waters where they develop into swimming tadpoles, eventually becoming frogs. All of these changes in a frog’s life occur under the control of hormones, which are chemical messengers that travel throughout the organism, turning on and off bodily processes. Because frogs live on both land and water along with breathing through their skin, they are particularly sensitive to chemical pollution.

www.highlevelwoodlands.com

Northern Leopard Frog Population Decline

According to the Minnesota Department of Natural Resources, Northern Leopard Frogs were once the most widespread species in North America. The population of this frog has been declining in Minnesota and throughout the United States since the 1960s. Common causes for this decline include: Red-leg disease, pollution, pesticides, loss of wetlands and other habitat, and killed by humans to be used as bait and for biology laboratories.

Frog Population Decline: Global & Local

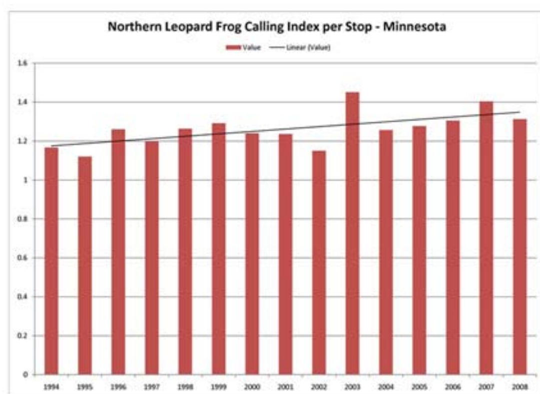
Over the last 10 years, the world population of frogs has seen an alarming decrease due to a number of factors:

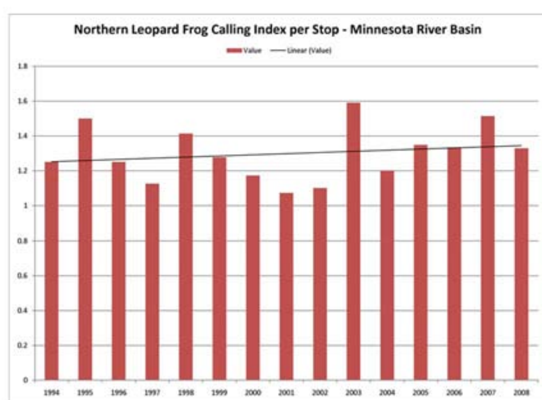
- habitat loss and fragmentation,
- ozone depletion (frog skin is sensitive to ultraviolet rays),
- acid rain or precipitation,
- chemical pollution, and
- increase in predators and non-native competitors.

In the early 1970s, harvesting of Northern Leopard Frogs yielded up to100,000 pounds before suffering a major population crash in 1973. This halted the commercial collection of the frog except for bait from 1974 to 1987. Today, Northern Leopard Frogs are still being collected heavily for fish bait and biological supply trade despite the significant decline of its population.

A petition to list the western population of the northern leopard frog as a threatened or endangered species by the Federal Government is currently under a scientific review by the U.S. Fish & Wildlife Service. Populations in nineteen states west of the Mississippi River and Great Lake including Minnesota would receive protection under the Endangered Species Act. According to the U.S. Fish and Wildlife Service, the northern leopard frog is experiencing threats from habitat loss, disease, non-native species, pollution and climate change that individually and cumulatively have resulted in population declines, local extinctions and disappearance from vast areas of its historical range in western U.S. and Canada.

The Minnesota County Biological Survey of the Native Plant Communities and Rare Species of the Minnesota River Valley Counties (September, 2007) conducted by the Minnesota Department of Natural Resources, found Northern Leopard Frogs in all but one of the 17 counties in the search area. Northern Leopard Frogs had been found in previous surveys from the 1990s in Ramsey County.





Malformed Frogs

Malformed Frogs

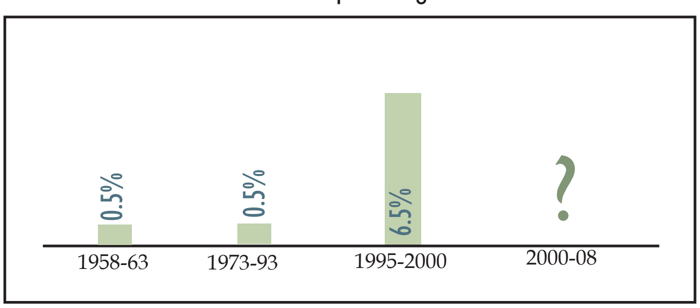
On August 8, 1995, a group of eight middle school students from the Le Sueur Community School discovered a large number of malformed Northern Leopard Frogs on a field trip to the Ney Nature Center overlooking the Minnesota River near Henderson. Out of the 22 frogs the students managed to catch, 11 had limb deformities.

From 1995 to 2000, frog surveys were conducted across the state of Minnesota. Approximately 6.5 percent of the 13,763 Northern Leopard Frogs found were malformed, including missing limbs, missing digits, extra limbs, partial limbs, skin webbing, malformed jaws, and missing or extra eyes. In previous studies (1958-63 and 1973-93) less than a ½ percent of Northern Leopard Frogs were found malformed.

Researchers who examined the malformed frogs found many with internal abnormalities including intestinal contents within the bladder or abnormal male gonads. Researchers also discovered normal bacterial, viral, and parasitic organisms in the frogs. Several common pesticides and heavy metals were detected within frog tissues.

Amphibians like frogs are excellent indicators of environmental stress because they live in both aquatic and terrestrial systems. Frogs have been called "sentinel" species because they have metabolic functions similar to humans and could be an early warning system for any potential troubles.

Percent of Malformed Northern Leopard Frogs found in Minnesota



Potential Causes

Malformations in amphibians, according to the U.S. Geological Survey's National Wildlife Health Center, that are caused by environmental factors affect individuals at the larval stage of development. Researchers point out that factors leading to malformations at a particular site may be different from those at another site. Four major environmental factors have been identified: contaminants, nutritional deficiencies, parasites, and injuries. A number of theories for malformations are being studied including the use of agricultural herbicides and natural causes like dragonfly predation. Some researchers feel it could be a combination of both man-made chemicals and natural predation.

Atrazine

One potential cause for malformed frogs has to do with the widely used agricultural herbicide Atrazine. According to research conducted by the University of Illinois, this popular weed killer increases the concentration of flatworms in waterbodies supporting amphibians and "also diminishes the ability of larval frogs to fight infection with these parasites."

In addition, phosphate fertilizer runoff flowing into a waterbody can increase the toxicity of atrazine. The fertilizer boosts the production of algae which in turn snails feed on. As a result, the frogs are stricken by an increase in snails because they serve as a primary but temporary host for the parasitic flatworms. These tiny flatworms can trigger debilitating limb deformities in frogs through infection and severe infection can kill the amphibians. A University of California study showed atrazine turned male frogs into hermaphrodites with eggs and ovaries, and can trigger human cancers. Since the 1990s, Atrazine has become a popular for farmers to use as herbicide especially in corn-growing regions.

Natural Predation

Two independent research studies (England and Oregon) discovered dragonfly nymphs were eating the legs of frogs (in some cases toads). The dragonfly nymphs at times would also eat a frog's eyes or tail but mostly went after the legs before releasing the injured amphibian. In lab tests the scientists found by amputating the hind limbs of a wood frog tadpole during different development stages either a full or partial leg would grow back.

Difference between Malformation & Deformation

- **Malformation:** process of disrupting a normally formed organ or body part during the original stages of development.
- **Deformation:** process of disfiguring a part of the body that already exists.

Fish Numbers Improving

Surveys show species diversity and abundance increasing since 1950s

Historical Perspective

From the late 1800s to the present, surveys by the University of Minnesota, the Minnesota Department of Natural Resources and the Minnesota Pollution Control Agency have documented 104 fish species in 24 families in the counties adjacent to the Minnesota River. "As a result of stream degradation from turbidity and other sources such as chemical contaminants, populations of many species are likely much smaller than in the past, and twelve of the 104 species previously documented in the drainage have not been seen for 30 years and are likely extirpated" (MCBS, 2007).

Recent Trends

In recent decades, water quality has begun improving in the Minnesota River drainage. Likely in response to some improvements in water quality, species diversity and abundance are increasing the Minnesota River (MCBS, 2007).

"Seine hauls (in the 1950s) frequently contained peas and carrots from canneries, human feces from untreated sewage, and not surprisingly, very few fish."

1950s
Dr. James C. Underhill
Curator Emeritus of the James Ford
Bell Museum Fish Collection
University of Minnesota

1980-82
based on 60 surveys

2005
based on 32 surveys

Fish Species Doing Well

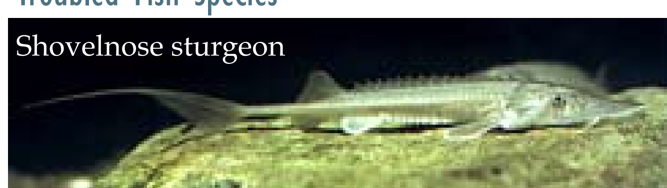

Flathead catfish
Konrad Schmidt

River supports healthy populations of:

- Flathead catfish
- Channel catfish
- Common Carp
- Walleye
- Sauger
- White bass

Ron Bolduan

Troubled Fish Species


Shovelnose sturgeon
Konrad Schmidt

Fish species in greatest conservation need:

- American brook lamprey
- American eel
- greater redhorse
- largescale stoneroller
- shovelnose sturgeon
- shoal chub

Fish Continued

Konrad Schmidt

The Blue Sucker Returns

One of the state's rarest fish, the blue sucker (*Cycleptus elongatus*), is reproducing once again in the Minnesota River. The blue sucker has been absent from the river for decades. Now the species has returned and is reproducing in the Minnesota River. Konrad Schmidt of the Minnesota Department of Natural Resources says sediment is a big problem for the blue sucker, so its return the Minnesota River is a signal of improved water quality. "The males, in the spring when they're spawning, become almost a sky blue in color," Schmidt says. "It really is a beautiful fish" (MPR, 2002).

Hawk Creek Watershed Project

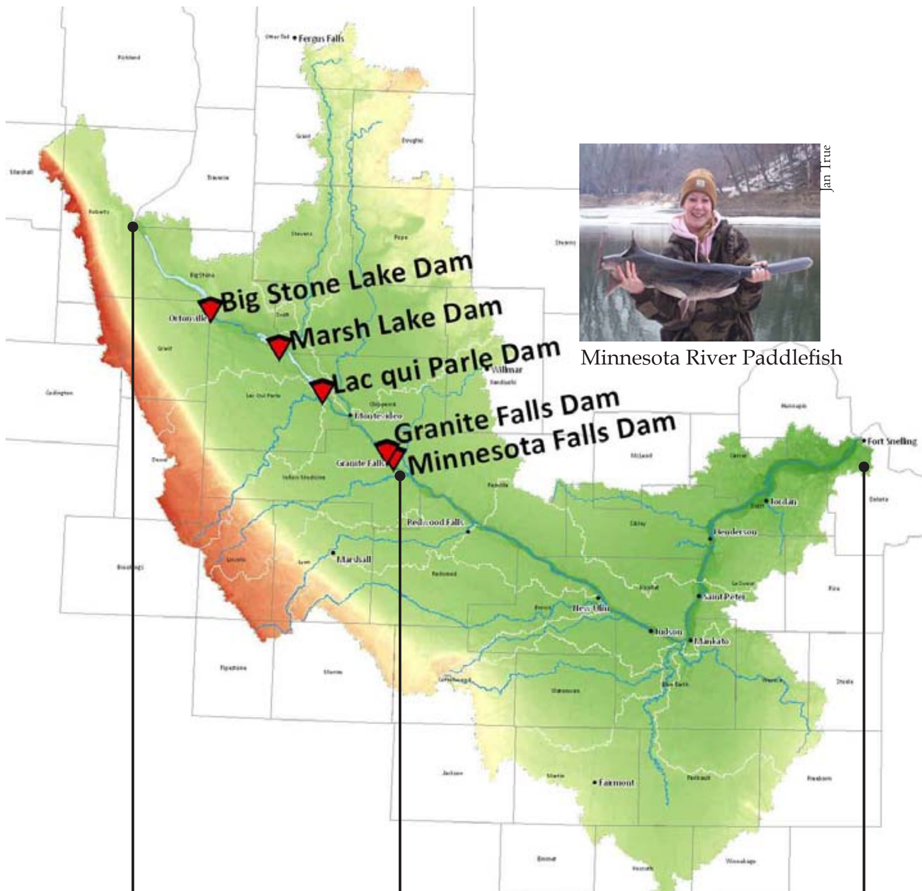
Excess Sediment and Fish

The mainstem of the Minnesota and many of its tributaries are extremely turbid, transporting enormous silt loads many miles downstream.

- Turbidity reduces light penetration which can eliminate submerged vegetation that provides fish habitat.
- Sediment deposits fill in the interstitial spaces in rocky substrates which are habitats for the invertebrate communities that feed many fish species.
- Some fishes require clean, exposed gravel and rubble to lay their eggs and develop. If the spaces are filled, the eggs suffocate.

Impacts of Dams

There are five dams on the Minnesota River mainstem. The first dam on the Minnesota River is at Minnesota Falls (near Granite Falls) about 250 miles upstream from the confluence with the Mississippi River. Except during floods, the five dams present barriers to fish migration. As a result, fish species diversity declines significantly from Minnesota Falls to the source of the river at Big Stone Lake. Prior to the dam era, at least two rare fishes (lake sturgeon and skipjack herring) were known to migrate annually up the Minnesota River to spawning areas in the lake.



Jan True

Minnesota River Paddlefish

Upstream of Minnesota Falls:

Five dams are barriers to fish migration (except during floods).

Fish species diversity declines significantly

From Minnesota Falls Dam to Mississippi River:

Longest free-flowing section of stream in Minnesota - 250 miles.

Richest fish species diversity.
Can find species such as:
Paddlefish (threatened)
Blue sucker (special concern)
Lake Sturgeon (rare)
Black buffalo (rare)

Bald Eagles

A success story—Bald Eagles have returned to the basin

Bald Eagle (*Haliaeetus leucocephalus*) populations in Minnesota have made a dramatic recovery since DDT was banned and they came under the protection of the federal Endangered Species Act in 1978.

The results of DNR's 2005 statewide bald eagle survey reflect a steady increase in Minnesota's bald eagle population over the past thirty years. The number of known active nests in the Minnesota River Basin have substantially increased. The growth of the state's bald eagle population appears to be slowing, but remains at a healthy level. Minnesota's bald eagle population appears large, healthy, and expanding.

Researchers are currently studying what baby eagles can tell us about environmental toxins. Along the St. Croix, Mississippi River, and Apostle Islands, National Park Service ecologist Bill Route has discovered DDT, PCBs, lead, mercury, flame retardants, and perfluorochemicals (PFCs) in baby eagle blood. Route said "the concentrations of PFCs found in a few nests have been among the highest measured in wildlife... but they don't seem to have slowed the eagles' population growth" (Route, 2009).

Pat Baskfield

Bald Eagles and nest near the Blue Earth River.

> *"Eagles, once rare, are now commonly seen along the river."*
> — Art Straub, Teacher, birdwatcher

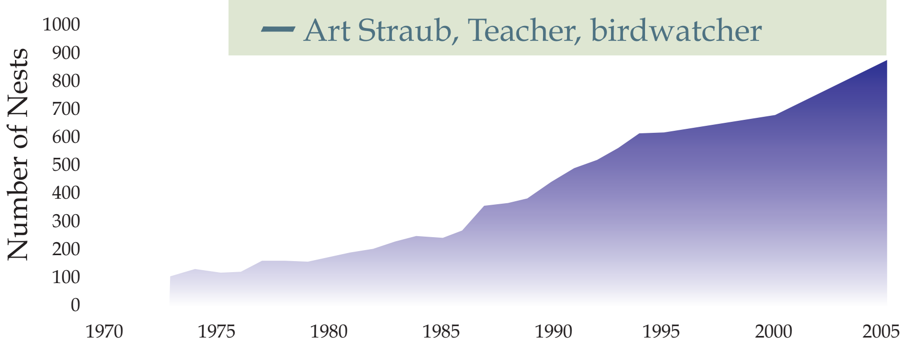


Chart illustrating the number of known Bald Eagle nests in Minnesota, 1973-2005.
Source: DNR, 2005

The map below depicts change in the number of known active nests from 2000-2005, by county. Note concentration of more than 30 percent increase (shown in black) in the Minnesota River Basin. Source: DNR, 2005

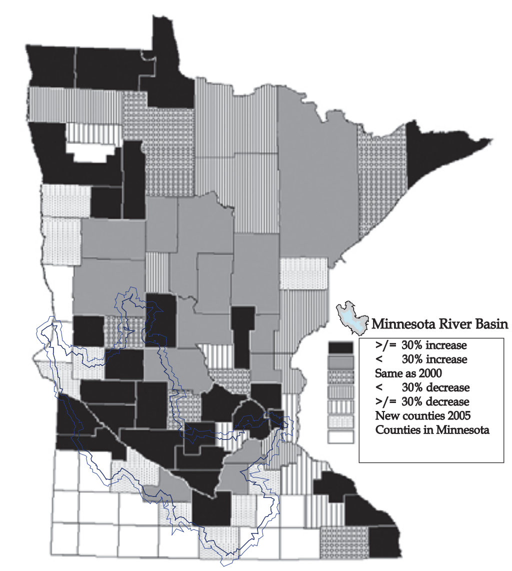


Figure 4. Change in number of known active nests from 2000 to 2005, by county.

Ring-necked Pheasants

One of Minnesota's most popular game birds, Pheasants, are rebounding

Originally imported from Asia, this hardy, wily game bird possesses a keen survival instinct and an uncanny ability to escape. Ring-necked pheasants are easily recognized by their colorful plumage and known for its delicious meat. In 1916, they were introduced in Minnesota They are primarily found in the southern two-thirds of Minnesota, occupying all or parts of 68 counties. Even though ring-necked pheasants are a hardy bird they experience a high turnover rate, especially among the young birds. Food and cover are key factors for their survival.

Chris Kayler Photography

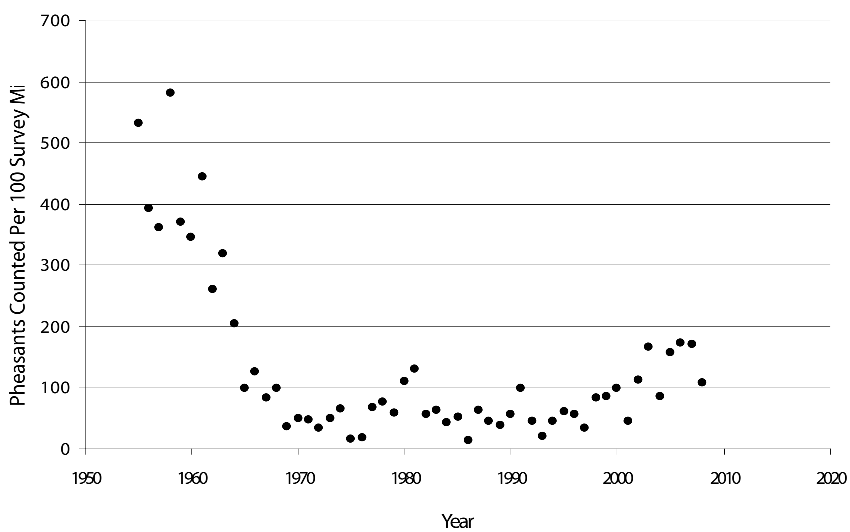
Intense farming practices including minimal small grain crops along with substantial use of pesticides and chemical fertilizers are hard on pheasants. According to resource managers, pesticides destroy weedy and woody cover needed for protection and destroy insects needed by young for rapid development. In addition, chemical fertilizers can cause nitrite poisoning.

Changes in Available Habitat

Habitat for pheasants continue to be affected by the loss of Conservation Reserve Program (CRP) acres. This loss isn't as great as states like South Dakota, but according to DNR officials it is still going backwards. Some of this decline has been offset by an increase of acres in Minnesota's State Wildlife Management Areas Program (WMA). DNR officials report around 5,000 acres are added each year in the state's pheasant range. Some counties in the Minnesota River Basin like Renville County have a large number of acres – nearly 16,000 – enrolled in RIM/CREP/WRP providing habitat for pheasants and other wildlife.

"Pheasant populations respond to changes in grassland habitat abundance and weather. Our survey was not designed to detect changes in habitat alone. So the recent increase in pheasant abundance may be as much a function of less severe winters as more grass habitat."
Kurt J. Haroldson,
DNR Wildlife Research Biologist

Pheasant Population Trends: Minnesota River Basin



1955-70
Dramatic decline in pheasant counts

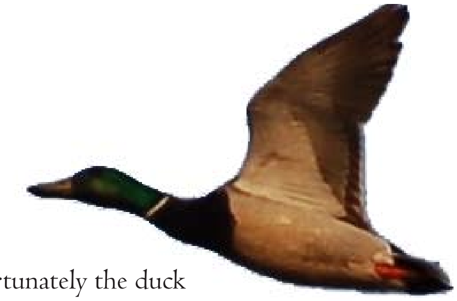
1970- mid-90s
Relatively low and stable numbers

2000-2010
Gradual increase

1980s
"You may expect to see an increase in pheasant abundance in the late 1980s when the Conservation Reserve Program (CRP) got started. But for every acre of CRP that was added to the pheasant range, 3 acres of pasture, hayland, and small grains (alternate grassy habitats) that pheasants use for nesting were lost." —Kurt Haroldson, DNR

Ducks

Swan Lake—a connection between water and upland habitat



The Minnesota River Basin is located in the so-called "duck factory," considered North America's best waterfowl breeding habitat and one of the most important duck breeding areas in the world. This area covers the southern part of Minnesota along with the Dakotas, Iowa and central Canada. Much of the prairie and wetlands originally found in the "duck factory" area have disappeared and what remains faces continued pressure to be broken up and drained for agricultural production. Ducks rely on upland areas around wetlands and shallow lakes for both nesting and as a food source.

One of the most important breeding areas for ducks in the Minnesota River Basin is Swan Lake located in Nicollet County. Swan Lake is over 10,000 acres and called the largest prairie pothole marsh in North America and home to many migratory birds and waterfowl including mallard ducks. From the turn of the century into the 1950s, a large number of market hunters traveled to Swan Lake to harvest waterfowl for restaurants as far away as Chicago. Swan Lake remains a favorite designation for duck hunters with the duck opener attracting over a thousand hunters.

In the 1950s, a dramatic transformation occurred on the landscape surrounding Swan Lake when pasture and hayfield used for dairy farming were plowed under and planted for row crops. This transformation also included the installation of field drain tile and digging of a countywide ditch network to help increase yields of corn and other crops, effectively changing the watershed's hydrology. All of this new drainage reduced the size of the Swan Lake Watershed from 27,000 acres to 16,500 acres. Duck production fell from 18,000 in 1947 to less than 100 in 1984. Two years later the MN DNR initiated a ten-year Swan Lake Area Wildlife Project to increase upland habitat and develop an effective water management plan.

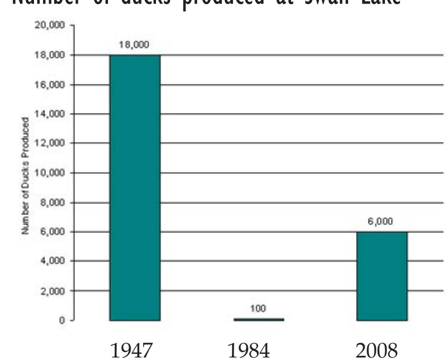
According to the Swan Lake Restoration Project Final Report, it has nearly accomplished its goal of producing 10,000 ducks per year; estimates suggest that the lake annually produces between 6,000-8,000 ducks. Large numbers of ducks use the lake as staging area during their fall migration. Improvements of the water control and drainage systems have allowed the water level of Swan Lake to be managed in a timely fashion. The project did fall short of its goal for acquiring and restoring 8,000 acres of high quality upland acres. Today, Swan Lake faces another crisis for its duck population—the unexpected release of carp into the lake. Carp can drastically reduce a duck's food source that includes invertebrates, fish, amphibians and a variety of plants.

Unfortunately the duck population across the Minnesota River Basin generally isn't as healthy as that found in the Swan Lake Watershed. With the elimination of nearly 95 percent of wetlands in the basin over the last 80 years, there is less habitat and food sources for ducks. Many of the remaining wetlands have degraded water quality and quantity. The immense drainage system put in place across the basin has significantly decreased the duck population capability.

Brown Nicollet Cottonwood Water Quality Board

Swan Lake—Largest prairie pothole marsh in North America. Home to many migratory birds and waterfowl.

Number of ducks produced at Swan Lake



Historical Accounts of Ducks in the Minnesota River Basin

Danny Martin

Blue-winged Teal

George Featherstonhaugh paddled the entire Minnesota River in 1835 and recorded some observations of ducks on this trip:

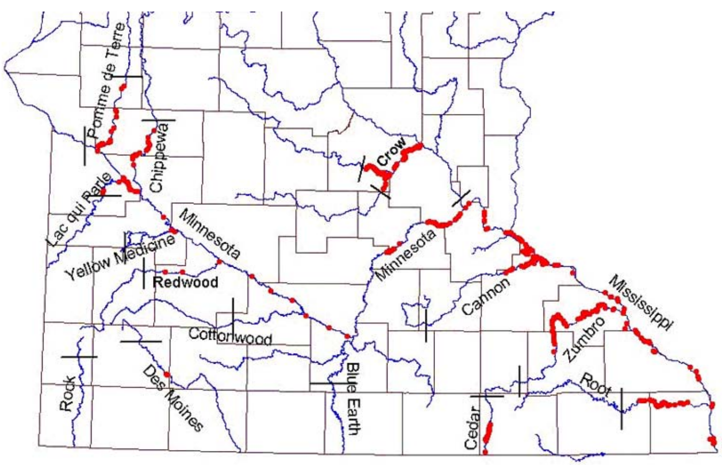
- "The banks [are] flat and abounding in ziziania [wild rice] and wild ducks and teal, that flew up in clouds as we advanced" (September 29, 1835).
- "As we advanced the quantity of wild ducks and geese became enormous, but they were shy, and generally rose before we could get within shot . . . all of them were fast, and many of them had the most beautiful plumage, especially the gaudy-crested wood-duck, which is a common bird here" (September 28, 1835).
- "As we advanced through these low rice—grounds, clouds of wild ducks rose on the wing, and we killed them at our leisure from our canoes" (September 30, 1835).

River Otters

Minnesota's largest aquatic carnivores are rebounding

2000 & 2001 MDNR
River Otter Survey of the Minnesota River Basin

On the Minnesota River, activity was most abundant on the upper and lower portions of the river, with few and scattered observations on the middle portion of the river. Lower activity on the middle Minnesota River likely illustrates the increased time it takes for a species with fairly low reproductive output to naturally disperse and repopulate distance areas, rather than reduced habitat quality in this section of the river. However, for some tributaries of the Minnesota River, water depths and fish populations may be inadequate to support otter populations year-around. Nevertheless, such tributaries may represent important seasonal habitat, for example during offspring rearing. Further evaluation would be necessary to determine the seasonal suitability of these areas.
Source: John Erb and Chris DePerno of the MN DNR, "Distribution and Relative Abundance of River Otters in southern Minnesota."



Distribution of otter sign detections from winter aerial surveys

River Otter Timeline

Pre-settlement – Widespread
River Otters are present or at least occasionally used most waterways including the Minnesota River .

Early 1900s – Decline
River Otter range is greatly reduced because of wetland drainage and destruction of habitat, as well as unregulated harvest, particularly in the southern half of Minnesota.

1977 – CITES Protection
MN DNR mandates registration of otter pelts after the Convention on International Trade of Endangered Species (CITES) determines the river otter resembles many endangered otter species worldwide and falls under the CITES rules.

Early 1980s – Reintroduction
In the early 1980s, 21 otters are released in the upper Minnesota River basin in west-central Minnesota.

2000 & 2001 – MDNR Survey
MN DNR conducts winter aerial surveys across the state's southern part including the Minnesota River Watershed.

Today – Rebounding
There are an estimated 11,000 otters in the state (mostly in the northern half of the state but with increasing numbers and distribution in the south).

River Otter Mortality Factors

- Draining of wetlands,
- Regulated trapping,
- Susceptibility to pollutants – mercury, DDT and PCBs,
- Loss of habitat,
- Vehicle collisions

About River Otters

This social mammal is known for its child-like personality and often appears to spend time playing. While many of these behaviors appear "play" to humans, they likely evolved as practical behaviors related to hunting sucess, grooming, and efficient travel. River Otters have been observed to slide down snow or mud covered stream banks, tag each other and drop pebbles into the water to retrieve them. They are well adapted for swimming with webbed toes, long tail and a torpedo-shaped body that allows them to move up to seven miles per hour in the water. A river otter will eat fish, frogs, insects, mussels, crayfish, turtles, and small mammals like muskrats, chipmunks, mice, and young rabbits. In the water, otters are usually safe from predators but on land they can be killed by bobcats, coyotes and wolves. Otters are also known for being "tireless travelers" – moving up to 25 miles in a week's time. In the spring, a female will give birth up to five cubs, which remain with the parents during the first winter before going off on their own.

Increased River and Lake-Focused Recreation

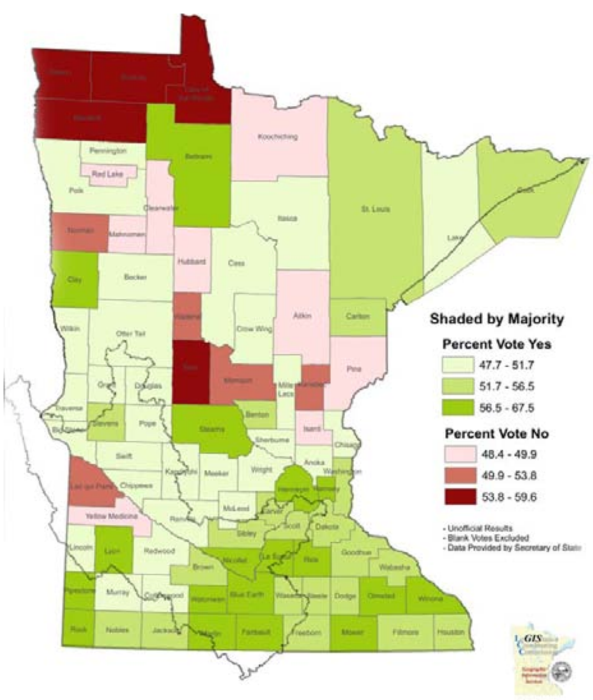
The following section summarizes some trends in river and lake focused recreation across the Minnesota River Basin. Findings show more boat access points and interest in boating and paddling. There appears to be a renewed interest in fishing across the basin with bigger walleyes and catfish being caught as well as more sturgeon and paddlefish. Although health concerns remain with swimming in rivers and streams, more people are visiting State Parks and taking advantage of recreational opportunities across the basin.

The DNR performs an "Awareness and Satisfaction Survey" to a random sample of Minnesota residents. In the 2000 survey, the number one environmental issue among survey respondents continued to be: "The whole area of protecting lake and rivers, surface water use, and shore land protection. Whether it is protecting lakes and rivers from waste, controlling milfoil, managing lakeshore development, or protecting wetlands, this general area has been of the most concern, and a source of some dissatisfaction."

Scott Kudelka

"The Minnesota River winds for 330 miles through the heart of Minnesota. It also winds through the hearts of many Minnesotans. It is clear from talking to people who live on its banks, float on its currents, embrace its history, that there is a growing awareness of the value of this remarkable resource." — John Cross

Constitutional Amendment
The Clean Water, Land and Legacy Amendment

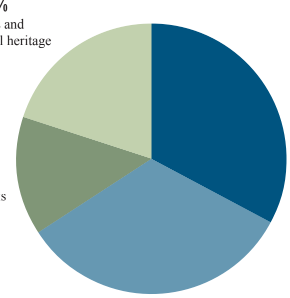


Source: Legislative Coordinating Commission's Geographic Information Services

In 2008, a state constitutional amendment to bolster funding for the outdoors was supported by Minnesotans and particularly by residents in the Minnesota River Basin. On the map at left, a majority of "yes" votes is depicted as green. It was passed by 56 percent across the state and received particularly strong support in southern Minnesota.

The Amendment will likely raise between $270 million and $300 million to pay for natural resources programs, cleaning up our waters, rivers and lakes, funding park and trail projects and supporting arts, historical and other cultural programs. The amendment reads: "Shall the Minnesota Constitution be amended to dedicate funding to protect our drinking water sources; to protect, enhance and restore our wetlands, prairies, forest, and fish, game and wildlife habitat; and to protect, enhance, and restore our lakes, rivers, streams, and groundwater by increasing the sales and use tax rate beginning July 1, 2009, by three-eighths of one percent on taxable sales until the year 2034."

Distribution of Amendment Funds



State Park Visitation

Selected Minnesota’s State Park visitation rates increase

The Minnesota River Valley has seven state parks, one state recreation area (Minnesota Valley) and one wayside area (Joseph R. Brown) going from Fort Snelling at the confluence with the Mississippi River all the way out to Big Stone Lake near the state’s western border. Other state parks include Lac qui Parle, Upper Sioux Agency, Flandrau (on the Cottonwood River), and Minneopa. Each of the state parks offers water-based recreation opportunities including swimming, fishing and paddling, along with access to the nearest waterbody. Annual visitation rates range from around 40,000 to almost 800,000.

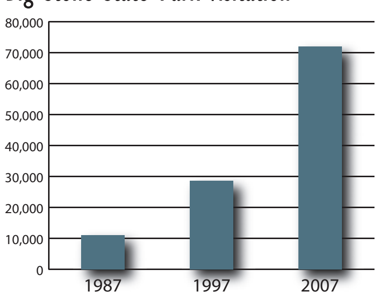
Big Stone Lake State Park

Located along the northeastern shore of the 26-mile long lake on the South Dakota border, this park features a boat launch, swimming beach, campground and Bonanza Education Center. Big Stone Lake State Park was established in 1961.

Visitation Overview

- Construction of a comfort station (showers and flush toilets) and swim beach since 1987.
- More people visiting from urban areas.
- Lake access is No. 1 reason for visitation.
- Campsites are close to the shoreline.
- Good fishing opportunities – especially being a border lake and having an earlier fishing opener than South Dakota.
- Boat access areas are in good condition.
- Summer algae blooms have negative impact.

Big Stone State Park Visitation



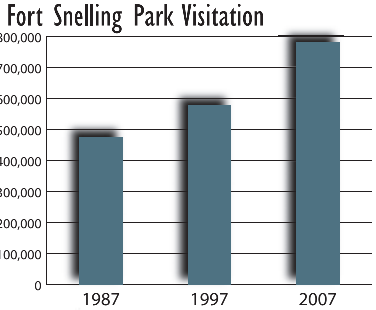
Fort Snelling State Park

This day-use only park sits at the confluence of the Minnesota and Mississippi rivers. Facilities include extensive trail system, swim beach and visitor center. Fort Snelling State Park was established in 1961 and is linked to the Minnesota Valley National Wildlife Refuge.

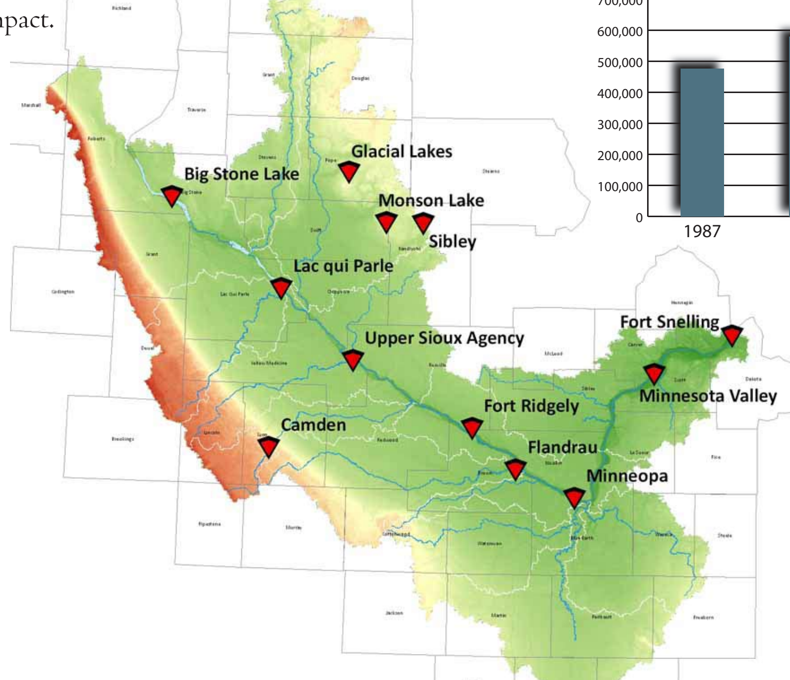
Visitation Overview

- Increase in visitation is likely due to rising gas prices—$4.00 in summer of 2008.
- Large number of visitors come from the Twin Cities area.
- Park manager assumes this increase is not tied to the river.

Fort Snelling Park Visitation



State Parks in the Basin



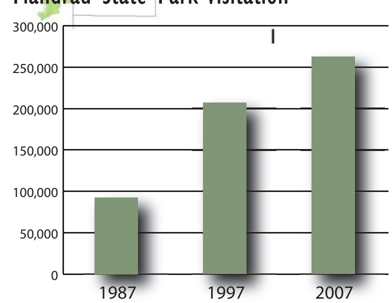
Flandrau State Park

The Cottonwood River flows through this park located on the edge of New Ulm. Facilities include a swimming pond, trails, campgrounds and group camp area. Established in 1930s, it once featured a 200-acre reservoir on the Cottonwood.

Visitation Overview

- Swimming pond is a big draw – biggest reason for visitation increase after it was built in 1989.
- During nice weather a lot of people come out to use the pond.
- Revenue changed dramatically after the construction of the pond.
- People are attracted to the scenic value of the river – they like to hike, ski, picnic, etc. near the water.

Flandrau State Park Visitation



Paddling & Boating

Boating, canoeing, kayaking on the rise

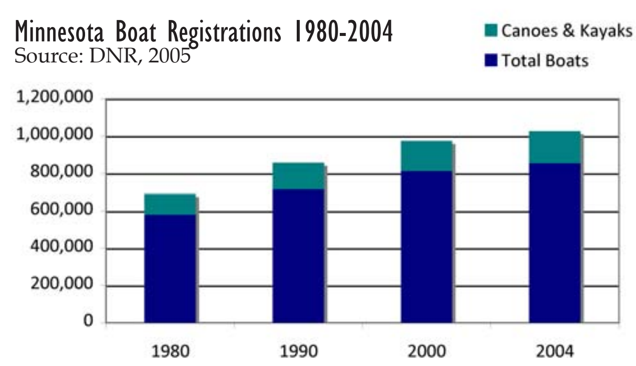
Scott Kudelka

Paddle quietly and feel the peace. Brush your hands on the 3.8 million year old granite outcroppings. Be startled by the slap of a beaver's tail, and be surprised by the butterflies and the eagles soaring over head. — Dennis Fredrickson, Minnesota State Senator

Minnesota Number One in Nation: Boats per Capita

With approximately 900,000 registered boats, Minnesota is number one in boats per capita in the United States. In fact, there is about one boat for every six people in the state. Recreational boating (which includes fishing from a boat) is one of the largest recreational activities in Minnesota. It is ranked second only to walking as an outdoor pursuit among Minnesota adults (DNR, 2005).

Most of Minnesota boating is motorized. Currently, only one in five registered boats in Minnesota is a canoe or kayak. In 2008, within the 37 county Minnesota River Basin, there was a total of 374,545 watercrafts registered and 79,290 canoe and kayaks registered. At 21 percent, this is similar to statewide trends.



Canoes and kayaks are used mainly on lakes in Minnesota (73% of use) and less frequently on rivers and streams (27% of use). Although used less than lakes, a statewide DNR survey showed that rivers have a positive image for paddlers. Survey respondents noted that their most important reasons for paddling were to enjoy nature (natural scenery, wildlife), to get away from life's usual demands (experience quiet, fresh air, and solitude), be with family and friends, to feel connected to nature, to catch fish, and to exercise. The survey also found that most canoeing and kayaking occurs near home within an hours drive of home (DNR, 2005).

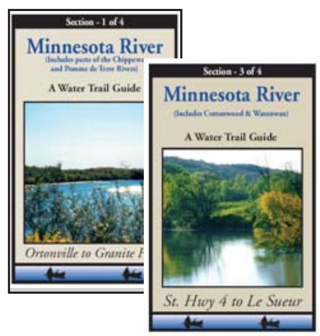
Scenic & Recreational River Designation

The Minnesota River was added to Minnesota's Wild & Scenic Rivers Program in 1977. The designated stretch extends from Lac Qui Parle Dam to Franklin.

DNR

Scott Kudelka

Canoe and Kayak Water Trail Designation & Maps



The Minnesota DNR designated portions of the mainstem Minnesota River and some tributaries as "Water Trails." DNR has developed a series of canoe and kayaking "Water Trail" maps. The detailed maps include information about public accesses and campsites along the river. These facilities are free and open to Water Trail users.

Water Trails in the Basin

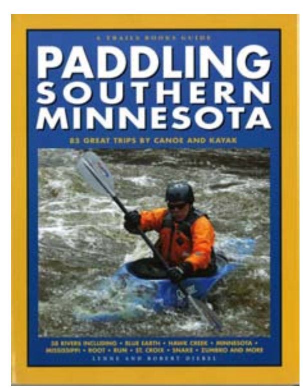
— Chippewa
— Minnesota – 4 sections
— Redwood
— Cottonwood
— Pomme de Terre
— Watonwan

Scott Kudelka

http://www.dnr.state.mn.us/watertrails/minnesotariver/index.html
http://www.dnr.state.mn.us/water_access/counties.html

Recent Paddling Books Published

Recent paddling books published indicate increased interest and demand by recreationalists. "Paddling Minnesota" was published in 1999 and "Paddling Southern Minnesota" was published in 2007.



River & Lake Recreational Access

Easier access—more boat ramps and access points

Overview

The Minnesota River served as an important means of transportation for American Indians along with early explorers and European settlers. Henry David Thoreau traveled up the river in 1861 on a steamboat, the principal means of movement until the construction of railroad lines starting in the 1870s. People began to turn their back on the river as only a few brave souls ventured onto the river to paddle. Until the 1970s and 1980s there were only a handfull of established water access points on the Minnesota River and its tributaries. That all changed when the Department of Natural Resources began working with local government agencies and nonprofit groups to develop access points and canoe camping sites up and down the river.

Water Access Points

1960s 7 boat launches from Big Stone Dam to the Twin Cities

—River Survey by Clyde Ryberg and State Senator Henry McKnight in 1963.

3 improved boat accesses

—Biological Reconnaissance from Lac qui Parle Dam to Mankato in 1966.

Today 46 water access points from the Big Stone Dam to Fort Snelling

(There are another 12 water access points on Big Stone Lake for both MN and SD)

Canoe & Kayak Rentals

Today there are a number of ways to get out and paddle the Minnesota River or one of its many tributaries. Ten groups and businesses across the basin rent canoes and/or kayaks (Clean Up the River Environment – CURE; Redwood Cottonwood Rivers Control Area (RCRCA), Minnesota River Adventures – Catfish Tom; Upper Sioux Agency State Park; MN State University Mankato Recreation Center; A-Z Rental in Mankato; Kato Canoe & Kayak; Dawson Mini-Mall; Mitlying's Bait and Lentz Outfitters (Echo). In addition, a nonprofit group in Granite Falls is working to restore a flood damaged building on the Minnesota River to be used as a canoe/kayak rental shop.

Groups that Sponsor Paddles

Six nonprofit groups established in the 1990s are working to help promote paddling opportunities in the Minnesota River Basin (CURE, Twin Rivers Canoe & Kayak Club, Chippewa River Canoe Club, Mankato Paddling & Outings Club, Tatanka Bluffs and the Minnesota River Watershed Alliance). To award people who have paddled a variety of rivers in the Minnesota River Basin, CURE offers the Prairie Paddle Patch (paddle 6 rivers in the Upper Minnesota River Watershed) and the Watershed Alliance sponsors three different paddler patches/decals. The Tatanka Bluffs nonprofit organization is spearheading a project to improve access points, camp sites, drinking water hydrants and other paddling-related infrastructure.

Paddling Trips

A number of annual paddling trips are offered by nonprofit organizations and watershed groups in the Minnesota River Basin (Chippewa River Watershed Project, Lac qui Parle Watershed Project, CURE, RCRCA and the Mankato Paddling & Outing Club). These organized paddles help people experience the different rivers and promote recreational opportunities.

Scott Kudelka

Minnesota River at Kinney, Upper Sioux Agency

Scott Kudelka

Minnesota River at Vicksburg Park, Renville County

Scott Kudelka

Minnesota River at Riverside Park, New Ulm

Scott Kudelka

Minnesota River at Judson

Scott Kudelka

Redwood River

Swimming
Elevated bacteria levels pose risks to swimmers' health

Because it has not been well documented, trends in swimming are difficult to assess. Absent historical studies, some anecdotal evidence provides glimpses into perceived and actual risk to swimming in the lakes and rivers throughout the basin.

1923 — Anecdotal Evidence of Swimming in River
In 1923, Alice McCormick used to take a dip in the shallows of the Minnesota River. Now 82, she still lives along the river. What was different about the old days? "My dad used to cut ice from the river" to keep food cool in the summer. She said she wouldn't swim in the river today. "I wonder if they'll ever be able to clean it up," she said.

River In Crisis by the Star Tribune, December 12, 1999

1934 — Minnesota Department of Health deems river unfit for human contact
In 1934, the Minnesota Health Department found that the river suffered from the effects of pollution coming from industrial, domestic and farm runoff. Their report found that although the river was "used for bathing at a great many places," it was unfit even then for human contact. At that time, habitat within the Minnesota River system was already considered "unfit for the development of fish."

Working Together: A Plan to Restore the Minnesota River – 1994 – Minnesota River Citizens' Advisory Committee Final Report to MPCA.

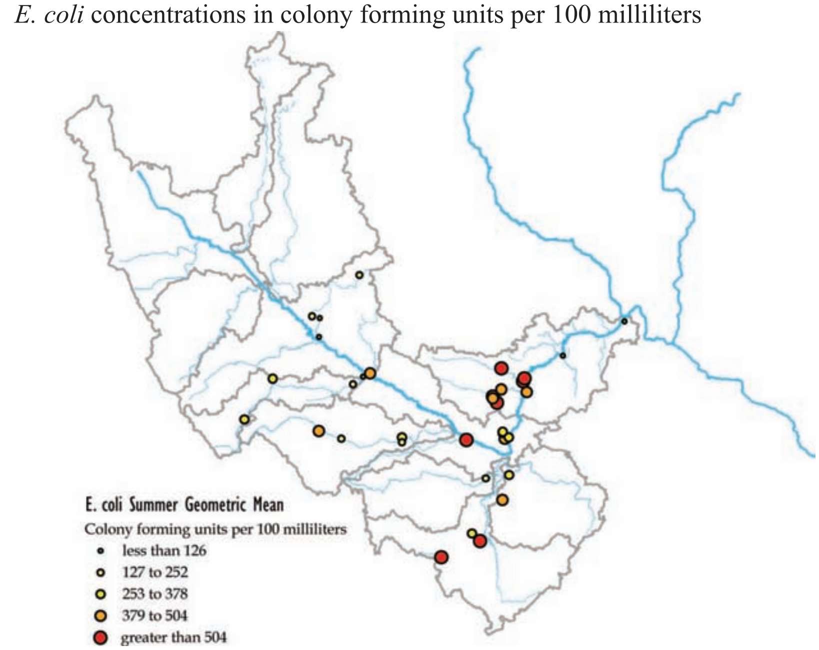
1966 — Minnesota Department of Health tests show bacteria counts in excess of safe levels
Swimming in the Minnesota River is not advisable. Water tests conducted by the State Board of Health show coliform bacteria counts in excess of safe levels. The Minnesota River A Biological Reconnaissance – Lac qui Parle Dam to Mankato; Minnesota Conservation Department Division of Game and Fish; Special Publication No. 37 – September 1966

Ron Bolduan

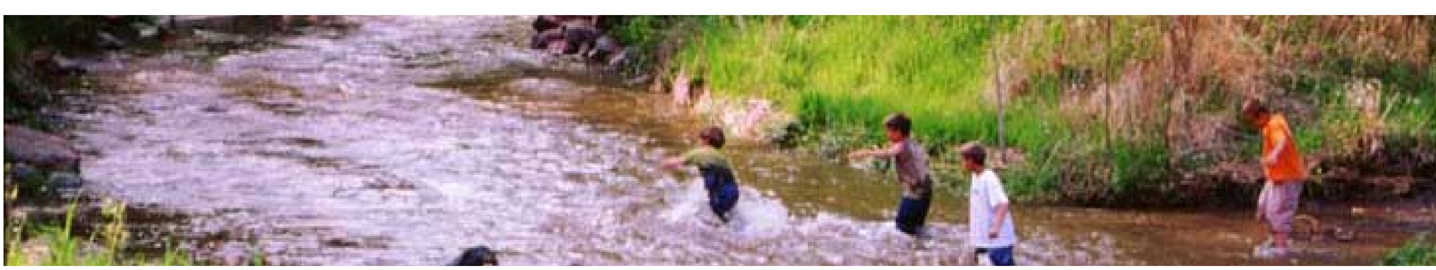
Redwood River rope swing

Today—Minnesota Department of Health Standards
Safe to swim standards are determined by the Minnesota Department of Health based on bacteria levels. For most water bodies in the state, standards for bacteria are designated by law to support full or partial body-contact recreational uses such as swimming, wading, boating, and fishing. The presence of fecal coliform or *E. coli* bacteria is an indicator of pollution caused by sewage or animal manure. When standards are exceeded, the water is considered impaired and not fully supporting the designated use. Many water bodies across the basin do not meet state water quality standards for bacteria and are listed on MPCA's Impaired Waters list. Monitoring data show indicator bacteria (fecal coliform and *E. coli*) levels are elevated across the entire basin with greater than 90 percent of monitored streams exceeding health standards for bacteria. People using impaired waters for recreation are at risk for exposure to pathogens (MPCA, 1997). Another swimming concern is Toxic Blue Green Algae (see lakes).

Bacteria in the Minnesota River Basin
E. coli concentrations in colony forming units per 100 milliliters



The map above shows summer *E. coli* concentrations (geometric mean) across the basin for sites with at least 20 samples. The state water quality standard for *E. coli* is 126 cfu/100ml.



Kimberly Musser

Kids Wading in Seven Mile Creek

Fishing

Fishing appears to be on the rise

Fishing the Minnesota River & Tributaries

Steady increases in fishing angling licences across Minnesota and within the 37 counties within Minnesota River Basin suggests a growing interest in fishing. Bait shop owners are seeing more customers and long time fishermen are noting catching more rare species such as sturgeon and paddlefish.

Scott Kudelka

Fishing in the Minnesota River

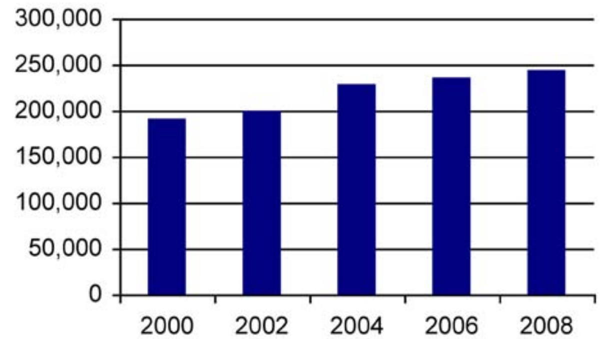
www.fishingminnesota.com

Walleye caught in the Minnesota River

Individual Angling License Sales in Minnesota

An increase in angling licenses in Minnesota from 1957 to 2008 suggests increasing rates of fishing across the state.

Individual Angling License Sales in the Minnesota River Basin



Angling license sales in the 37-county Minnesota River Basin show a steady increase from 2000-2008.

"People, still lament the water quality of the river, but it has really improved. You can see it with your own eyes. When you're seeing sturgeon – everyone is catching them – that's a water quality indicator. And people are catching paddlefish, that's a water quality indicator. It's not great. But it's not all doom and gloom. A lot of progress has been made."

Scott Sparlin - Friends of the Minnesota River Valley, CCMR, Fisherman

Fish Consumption Advisories Remain

The Minnesota Department of Health issues fish consumption advisories for lakes and streams in Minnesota where fish have been tested. The advisories contain recommended rates of consumption based on contaminant levels in the fish. The Minnesota Department of Health provides two types of advice on how often fish can safely be eaten: 1) Statewide Safe Eating Guidelines and 2) Site-Specific Advice. The primary contaminants of concern in the Minnesota River Basin are mercury and polychlorinated biphenyls, or PCBs. Current consumption advice for the Minnesota River shows recommended restrictions for the upper portion of the basin (above Minnesota Falls) primarily due to mercury in fish. Below Minnesota Falls, fish are more likely to be contaminated with PCBs and carry more stringent consumption advisories than the upper portion of the basin. To learn more about advisories, see: http://www.health.state.mn.us/divs/eh/fish/eating/index.html

Mercury Levels in Fish Rising

A recent MPCA study found that after falling for years, mercury levels in large fish are unexpectedly on the rise. The study looked at methylmercury concentrations in northern pike and walleye in 845 selected lakes throughout Minnesota over a 25-year period from 1982 to 2006. Mercury levels in northern pike and walleye fell 37 percent from 1982 to 1992 after the state began limiting the discharge of mercury. From 1996 to 2006 mercury concentrations in fish studied rose by 15 percent. MPCA scientist Bruce Monson said the source of the mercury probably is not local because the trend is statewide. Monson said the cause is probably either increased global mercury emissions by sources outside the United States, such as China or India, or factors associated with climate change, or both. Global mercury emissions increased between 1990 and 1995, largely because of an increase in electricity produced by coal-fired power plants in Asia. Reversing this trend requires a worldwide solution and the United States recently began negotiations for a new global treaty to control mercury pollution (MPCA, 2009).

Survey of Bait Shops Owners in the Minnesota River Basin

Many diverse bait shops in both rural and metro areas can be found across the Minnesota River Basin. Some are family owned and operated, while others are larger corporate sporting goods stores. To get a better understanding of fishing trends we interviewed seven bait shop owners around the basin and asked them a series of questions related to fishing and water quality.

A summary of their responses follow:

• Most of the bait shop owners report increased demand for fishing supplies. For some it is either very good or good. "I have seen an increase in the number of [people fishing]. More people fishing brings a greater demand for the supplies."

• In terms of selling fishing licenses, it has stayed relatively stable - for some either a slight increase or decrease. "I think it is steady, not really up or down."

• New customers are a regular occurrence for the bait shop owners, with a majority being males in their early to mid twenties. "Every day I have new people. Parents bring in their kids and they keep coming back. I think there are just about as many men as women and all kinds of ages. Maybe a little older people. If parents do a lot of fishing, the kids will take after that."

• There has been no change in the number of Minnesotans fishing compared to those from out-of-state. "Quite a few people from Iowa are fishing for catfish. I would say it is about the same as the past."

• Some of the bait shop owners have noticed a change in the type of fish being caught. "Bigger sturgeon, shovelnose sturgeon, and paddlefish [are being caught.] This is a sign that the river is cleaning up. Walleyes are bigger. More people are catching and releasing catfish. A few years ago 20-30 pound catfish were good, but the biggest this year was around 66 [pounds]. The average is the upper 30 pounds now. Those doing catch and release are better. The sturgeon increase was a big surprise, and the bigger walleyes." Others report it has been pretty constant. Most of them have seen more catfish being caught.

• All of the bait shop owners noted improvements in water quality with changes in the level of pollutants and fishing projects. "A lot cleaner, not as murky, foamy [as it was]15 years ago. [I] attribute [it] to people cracking down on [the] river, people not dumping as much."

http://www.watersheddistrict.org/fishing%20river.html

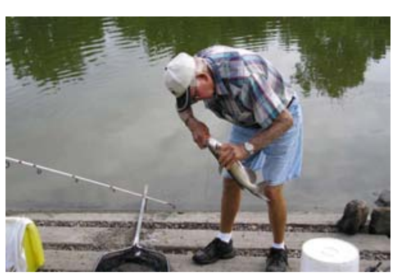
"Not too many years ago, tributaries pouring into the Minnesota River near Shakopee and Chaska would be foaming. We don't have that ... nor the real bad odor that was there. We have seen personally and through increased customers the comeback of the Minnesota River as a prime fishing haunt."
Terry Hennen, Owner,
Sport Stop Bait Shop, Shakopee

http://web.jjc.edu/clubs/anglers/

Shovelnose Sturgeon caught in the Minnesota River

http://www.minnesotafishingguide.com/

Fishing for Catfish



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Commercial Fishing

The Minnesota Department of Natural Resources (DNR) issued a permit to commercial fisherman for seining commercial species, primarily smallmouth and largemouth buffalo in the Minnesota River near New Ulm between State Highway 4 and State Highway 169 and cutoff oxbow lakes. According to the DNR, they saw this as an opportunity to observe, learn and subsequently discuss the future of commercial fishing in the river and the potential for using large mesh seines and/or observing commercial seining for sampling large Minnesota River fishes.

Fishing Technique

The commercial fishermen used a 5-inch stretch seine to deploy across the oxbows as they drove the fish using a wall of sound created by beating on the boats with metal stakes and using modified funnel to plunge the water. Once the boats reached the unanchored end of the seine a boat towed it over to the opposite bank to capture the fish. Small fish were allowed to escape as the rest of the catch was cribbed along the shore to be held for later transport by truck to New York for live sale.

Ron Bolduan

Ron Bolduan

What did they Catch?

This commercial fishing operation took place over two days in May and two days in June. Commercial fish netted during the seine included large numbers of bigmouth buffalo along with smaller amounts of common carp, smallmouth buffalo, and river carpsuckers. Game fish caught and released included northern pike, walleye and catfish. Numerous paddlefish were also caught and released ranging from 8 pounds to 32 pounds. The nets also captured false map turtles and softshell turtles.

Fish Hauls

- **First Haul** (May 19th) – total catch estimated at 5,000 pounds; largely bigmouth buffalo (represented approximately two thirds of the catch), smallmouth buffalo, common carp (one third of the catch) and carpsuckers; four game fish – two northern pike (estimated at eight and ten pounds) and two walleye (estimated six pounds).

- **Second Haul** (May 19) – approximately 10,000 pounds; proportionally similar to the first catch in both species and numbers (carpsuckers might have slightly more abundant); approximately 20 adult gizzard shad lodged in the mesh; a few freshwater drum along with one northern pike, two walleye and one white bass.

- **Third Haul** (May 20) – estimated 2,000 to 3,000 pounds; predominately bigmouth and smallmouth buffalo with smaller numbers of common carp and carpsuckers; one northern pike (estimated at 8 pounds), two walleye (estimated at 7 pounds) and one paddlefish (measured 42 inches and weighed 9 pounds).

- **Forth Haul** (June 4) – estimated total catch between 10,000 and 15,000 pounds; predominately bigmouth with small numbers of common carp, smallmouth buffalo and river carpsuckers; one gizzard shad and eight freshwater drum; northern pike (9 to 12 pounds) and walleye (6 to 9 pounds); four paddlefish (8 to 32 pounds)

- **Fifth Haul** (June 5) – estimated catch of 1,000 to 3,000 pounds of buffalo fish; two paddlefish of 48 and 47.5 inches ("the paddlefish swam away strongly"); three walleye (5 to 7 pounds).

Fishermen caught an estimated 28,000-36,000 pounds of fish over four days. Commercial fish netted during the seine included large numbers of bigmouth buffalo along with smaller amounts of common carp, smallmouth buffalo, and river carpsuckers.

EMERGING TRENDS

Ethanol


Scott Kudelka

Winthrop Ethanol Plant

In the 1980s, the State of Minnesota began to promote the production of corn-based ethanol to help reduce the United States' dependence on foreign oil and to provide a more stable market for farmers. Millions of dollars have been invested by Minnesota to construct ethanol plants across the state including 10 operating in the Minnesota River Basin along with a number of others either proposed to be built or currently being built in this watershed.

To process ethanol a large amount of water is needed (approximately 4.0 to 4.8 gallons of water per gallon of ethanol produced) not to mention the water needed to grow and harvest the corn. In 2008, the Gopher State Plant at Granite Falls consumed too much water from groundwater sources – depleting it – and was forced to pump out of the Minnesota River to keep producing ethanol. Statewide, the ethanol industry consumes about 2 billion gallons of groundwater per year. Water usage in ethanol production has become more efficient here in Minnesota but the production of ethanol is only expected to increase (it could quadruple by 2011), along with the use of water.

Most of the ethanol produced in Minnesota comes from corn, which helped fuel a dramatic increase in the amount of acres planted to this commodity as prices spiked at record levels in the summer of 2008. Land enrolled in the Conservation Reserve Program (CRP) took a big hit with over 80,000 acres across Minnesota removed from the program and converted back to agricultural production. According to resource officials, up to 800,000 of additional CRP acres could be lost over the next five years. All of this will have a major affect on habitat and water quality in the Minnesota River Basin. Some of this could be offset by the development of technology to use other plant material – grasses, trees, etc. – to produce cellulosic ethanol on an industrial scale. Unfortunately, most experts agree this could take as long as 5 to 10 years.

Emerging Contaminants

For well over a decade, scientists have been studying what they call "emerging contaminants" in our water and the effect it has or could have on us and aquatic organisms. Emerging contaminants are identified as medications, soaps, fragrances, cleaning products or chemicals we wash down the drain or flush down the toilet. These compounds were detected in 80% of the 139 streams examined by the U.S. Geological Survey in a 2002 study. They reported many of the sites were located downstream of urban areas.

Scientists are particularly worried about "endocrine disrupters," which mimic hormones. A wide range of chemicals fall under this category including certain cosmetics, shampoos, shaving lotions, skin creams, dishwashing liquids, pesticides, flame retardants, plastics and anti-bacterial soaps. No one really knows the long term effects on humans but for fish it has caused males to exhibit female characteristics including ovarian tissues that produce immature eggs. There is a concern among scientists that fish populations could decline because of the endocrine disrupters.

Humans don't live or breathe in the water, making us less vulnerable than fish to endocrine disrupters and no conclusive evidence has been found to link these emerging contaminants to human health problems. Although, some scientists are examining any potential connection between the well-documented trends of earlier puberty in girls and reduced sperm counts in men with endocrine disrupters in the water. There has been discussion to phase out or replace some of these chemicals and educating the public not to flush unused medication down the toilet.

Hard Rock Mining


Scott Kudelka

Some of the oldest known exposed rocks – 3.8 billion years old – are found in the Minnesota River Valley, in particularly along the river channel. These Gneiss outcrops and other granite rock outcroppings comprise some of the last remaining undisturbed areas in the basin. Granite rock outcroppings are under constant threat as the construction industry seeks new deposits of gravel to build our roads, homes and other modern infrastructure.

Granite rock outcrops hold some of the most endangered and unique native plant and animal populations in the basin. This includes the rare Great Plains prickly pear and brittle cactus along with the Five-lined Skink. Unlike prairie and wetlands which can be restored, once these granite rock outcrops are mined they are gone forever, along with the diversity of plants and animals that count on them.

A large section of the granite rock outcropping is located in a stretch of the Minnesota River that falls under the state's Wild and Scenic River Program. Designated in 1977, it extends from Lac qui Parle Dam to Franklin. Under this program, hard rock mining has been outlawed but it allowed the extraction of sand and gravel deposits. The demand for gravel and other rock will only grow stronger as elected officials, citizens, business interests and government agencies attempt to maintain a balance for protecting some of the most threaten areas in the basin and promote economic development.

Big Stone II Coal Plant


Scott Kudelka

This proposed coal-fired plant is being initiated by four private and municipal power companies as a major expansion of an existing facility on the South Dakota side of Big Stone Lake. As the second coal-fired plant at this site, it would generate between 500 and 580 megawatts of electricity to be distributed across new transmission lines in Minnesota. The State of South Dakota granted the power companies a permit to withdraw up to 3.2 billion gallons of water annually from the Minnesota River and another permit for 3.2 billion gallons of water from the Veblen Aquifer. Despite a call for reconvening the Minnesota-South Dakota Boundary Waters Commission by the Minnesota Department of Natural Resources and others, the permit was granted without any direct input from the State of Minnesota.

Environmental groups, government agencies and citizens have expressed major concerns about this proposed coal-fired plant due to the large water usage from the Minnesota River and an increase in mercury emissions, a potent neurotoxin that can cause permanent brain damage. A dramatic decrease of water levels in the Minnesota River, especially during drought situations could result in lower dissolved oxygen levels that cause harm to aquatic organisms including the potential for fish kills, along with a greater concentration of nutrients like nitrate and phosphorus that can stimulate excessive algae growth and be devastating on aquatic organisms. The Minnesota River is currently listed impaired for mercury residue in fish and the construction of a second coal-generated plant (largest emitters of mercury) could increase the already high levels. In 2008, the nonprofit organization American Rivers listed the Minnesota River as the fifth Most Endangered Rivers because of the proposed Big Stone II Coal Plant.


Big Stone II

Artist rendering of proposed expansion

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