

2017 Minnesota Environment and Energy Report Card



Table of Contents



LAKE MONONGALIA, MN

INTRODUCTION.....	4
WATER	10
LAND	14
AIR	18
ENERGY	22
CLIMATE	24

EQB's mission is to lead Minnesota environmental policy by responding to key issues, providing appropriate review and coordination, serving as a public forum, and developing long-range strategies to enhance Minnesota's environmental quality.

The report was prepared by the Environmental Quality Board with help from staff from several state agencies including the Board of Water and Soil Resources (BWSR), Department of Agriculture (MDA), Department of Employment and Economic Development (DEED),

Department of Health (MDH), Department of Natural Resources (DNR), Department of Transportation (MDOT), Department of Commerce (COMM), Metropolitan Council, and Pollution Control Agency (MPCA).

COVER IMAGE: Photo by Jeff Syme courtesy of Metropolitan Council. Taken at Minnesota State Fairgrounds in Falcon Heights

REPORT DESIGN: Bohte Design, llc

EDITED BY: Erik Cedarleaf Dahl

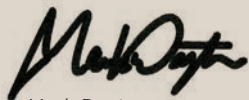
We must all be leaders

Minnesotans take enormous pride in our environment, but it is clear we face challenges as a state. The more we learn about the challenges facing Minnesota's environment, the more we see how complex and interconnected they are. Climate change is putting increasing stress on our environmental systems, and we can no longer take for granted the integrity of our water, land, and air. Although we have more data and better scientific analysis about our environment than ever before, finding solutions does not always come easily. Complex environmental issues test our ability to innovate, our political resolve to act boldly, and our willingness to collaborate across differences.

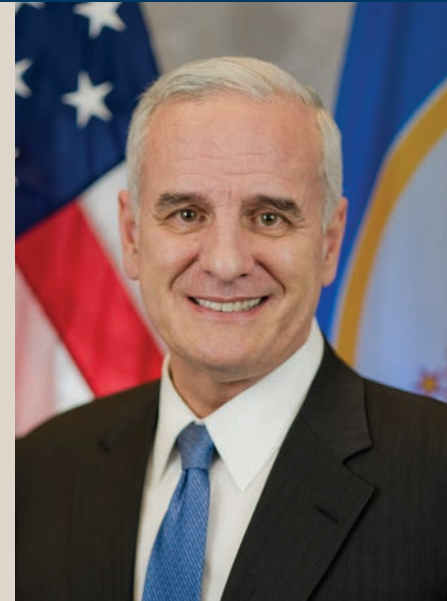
Acting boldly is essential, not just for the future of Minnesota's environment, but also for the world's environment. Decisions made at the local and state level have far-reaching effects and contribute to global issues such as rising greenhouse gas concentrations, the loss of biodiversity, and declining fresh water supplies. At the same time, Minnesota has the opportunity to model creative strategies that can be implemented elsewhere. We can be leaders in developing clean energy industries, progressive air, water and land policies, and public-private partnerships that benefit all citizens.

We also have the opportunity to be leaders in advancing environmental justice and equity. Building strong communities and economies means ensuring that all people of our state have equal access to the benefits of a healthy, clean environment and that no one group bears an undue burden of pollution, ecosystem degradation, or shortages of vital resources. We must structure our policies and institutions to achieve full and meaningful participation of Minnesota citizens and stakeholders. We are, in the end, all in this together.

Confronting Minnesota's environmental and energy challenges may cost money in the short term, but inaction will be much costlier in the long run. Environmental degradation erodes our economic vitality and diminishes the health and well-being of our citizens. We must be prepared to make tough decisions now to avoid pushing our environmental concerns down the road for the next generation to address. No single leader, institution, or business can accomplish this alone. To move forward we need all of us—citizens, government, industry, and the diverse communities across our state—to put our minds together, roll up our sleeves, and get to work.



Mark Dayton
Governor



Introduction

How healthy is Minnesota's environment? What are the priority environmental issues that require action? How do we enhance the well-being of all Minnesotans while protecting critical resources?

These are some of the questions that inspired the 2017 Minnesota Environment and Energy Report Card. EQB's goal is to evaluate Minnesota's environment so that we can measure our progress and prioritize our efforts. We also need a common language to discuss issues that cut across sectors and regions of the state. This Report Card is a snapshot in time of how we are doing and provides an opportunity to evaluate trends and continue the conversation on Minnesota's energy and environment.

Progress and Challenges

This report is organized around key areas of Minnesota's environment: water, land, air, energy, and climate. Each section presents three metrics that help us assess how well the environment is doing in these areas.

The metrics were chosen through extensive interagency dialogue and represent a collaborative effort to comprehensively evaluate our environment. The criteria are based on environmental and social data and were chosen to help tell a larger story about trends, challenges, and opportunities for action. In many cases, the metrics are tied to official state or federal goals.

This report is designed to be forward-looking, and focus on challenges the state faces. Minnesota still enjoys abundant natural resources and healthy ecosystems, yet many factors put increasing stress on Minnesota's environment. The majority of the metrics score in the yellow category, meaning that their status is not dire, but more work needs to be done. Some metrics scored in the red category, meaning that their status is poor. Minnesota's changing climate, our declining pheasant population, our reliance on petroleum, and nitrate in our groundwater are all issues that need urgent attention. Only one metric, Minnesota's household energy use, scored in the green category.

Making Connections

Impacts to one area of Minnesota's environment have ripple effects elsewhere. When energy use generates greenhouse gas

emissions, it can degrade air quality and contribute to climate change. Climate change, in turn, increases the likelihood of mega-rain events, which damage infrastructure and cause erosion, washing sediment into lakes, rivers, and streams. These interactions affect the health and well-being of our communities as well as the diverse ecosystems that make up our state.

Although our environment is highly interconnected, not all Minnesotans experience the issues highlighted in this report in the same way. Where we live, race, income level, profession, and cultural background all affect our exposure to hazards and access to environmental benefits. Some Minnesotans also have greater access to the decision-making processes that will determine future actions. Having frank conversations about who is impacted when we create policies or carry out projects is key for creating environmental equity in our state.

The Environment and Energy Report Card is a living document. We hope that it will inspire new dialogue and forms of action. Tackling the complex issues presented in this report will require innovative approaches and cross-sector collaboration. Together we can ensure a clean, healthy environment for Minnesotans.





LAKE SUPERIOR, MN

Indicator Species

Decisions we make about our water, land, air, energy, and climate affect our most emblematic wildlife in Minnesota. The species pictured here are sensitive to environmental conditions and can serve as a gauge for the broader health of our ecosystems.

The 2015 Minnesota Wildlife Action Plan identifies 346 animals as Species of Greatest Conservation Need (SGCN). Habitat loss, degradation, and fragmentation are considered prime stressors for 70% (241 of 346) of SGCN.

Each section of this report tackles one area of Minnesota's environment, but in reality, Minnesota's environment is interconnected. Safeguarding Minnesota's species require that we carefully consider the interdependence of our social, economic, and environmental systems.

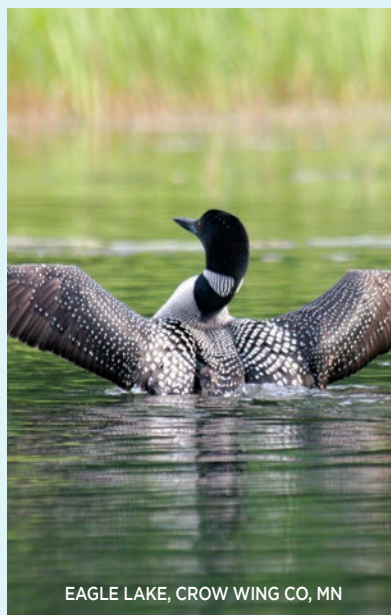
Each animal below faces a situation that indicates the habitat quality required to sustain viable populations. These species require sufficient habitat diversity and connectivity to allow access to resources, facilitate the animals' recolonization of habitats after a disturbance, and adapt to a changing climate.



TAMARAC NATIONAL WILDLIFE REFUGE, MN

Forests: Golden-winged warbler

Minnesota contains less than 10% of the golden-winged warblers' breeding range, but an estimated 47% of the breeding population nests in the state. The birds are Neotropical migrants, spending three to four months in the United States and Canada and wintering in Central and South America. The breeding population of golden-winged warblers has remained stable in Minnesota over the past 45 years. The species is an indicator of the diversity and connectivity of Minnesota's multi-aged forest.



Lakes: Common loon

Minnesota is tied with Alaska for the largest breeding population of common loons in the US. Loons are good indicators of lake water quality because they need clean, clear water to catch food and are sensitive to disturbance. The impact of climate change on lake conditions, as well as flooding of nests during extreme storm events, may reduce loon populations.

EAGLE LAKE, CROW WING CO, MN



Wetlands: Brush-tipped emerald

Minnesota's boreal peatland ecosystem system occurs at the edges of three biomes and is home to many unique plant and animal species, including approximately 24 species that are endangered, threatened, or of special concern. Across Minnesota, dragonflies and damselflies are good indicators of healthy wetlands.



PHOTO CREDIT: ROBERT P. DANA
LINCOLN CO, MN

Grasslands: Regal fritillary

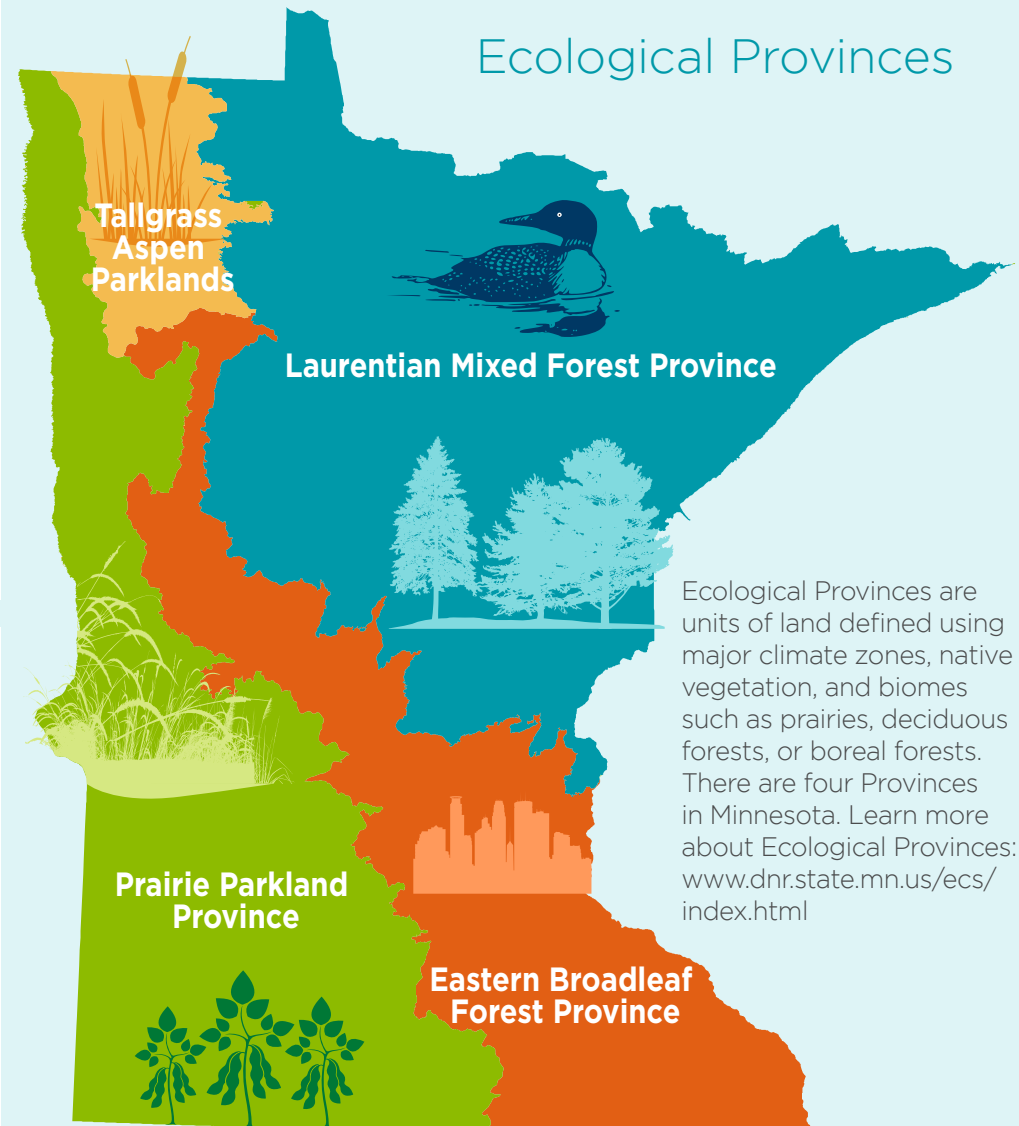
Less than 1% of native prairie remains in Minnesota, distributed in small fragments surrounded by agriculture and development. Few of these fragments are large enough to support regal fritillary populations. But when large prairie sites and smaller remnants are close together, butterfly populations are more resilient. Prairie butterflies, like the regal fritillary, are good indicators of the health of prairies.



ST CROIX RIVER, MN

Rivers and Streams: Black sandshell

Mussels are an important member of the aquatic community and an indicator of water quality. Twenty-seven of our 50 native mussel species are listed as endangered, threatened, or of special concern, and three species are no longer found in Minnesota. Activities that alter the flow of rivers affect black sandshell habitat.



Report Card

Participating agencies chose metrics based on availability and quality of data, and a metric's ability to communicate the status of protection and management of Minnesota's air, water, and land resources. Metric criteria were developed through interagency dialogue. While many Minnesotans experience a good quality of life, not all segments of the population have the same opportunities and positive experiences. Differences exist based on race, income, gender, disability, and geography.

GOOD. Green represents good current status. This means that performance is ahead of the desired progress toward state or national goals and/or established industry or agency benchmarks

OKAY. Yellow represents an okay current status. This means performance nearly meets public expectations, the desired progress toward states or national goals, and/or established industry or agency benchmarks.

POOR. Red represents poor current status. This means performance is well behind public expectations, the desired progress toward state or national goals, and/or established industry or agency benchmarks.

Color indicates current status.
Arrows indicate recent trends.



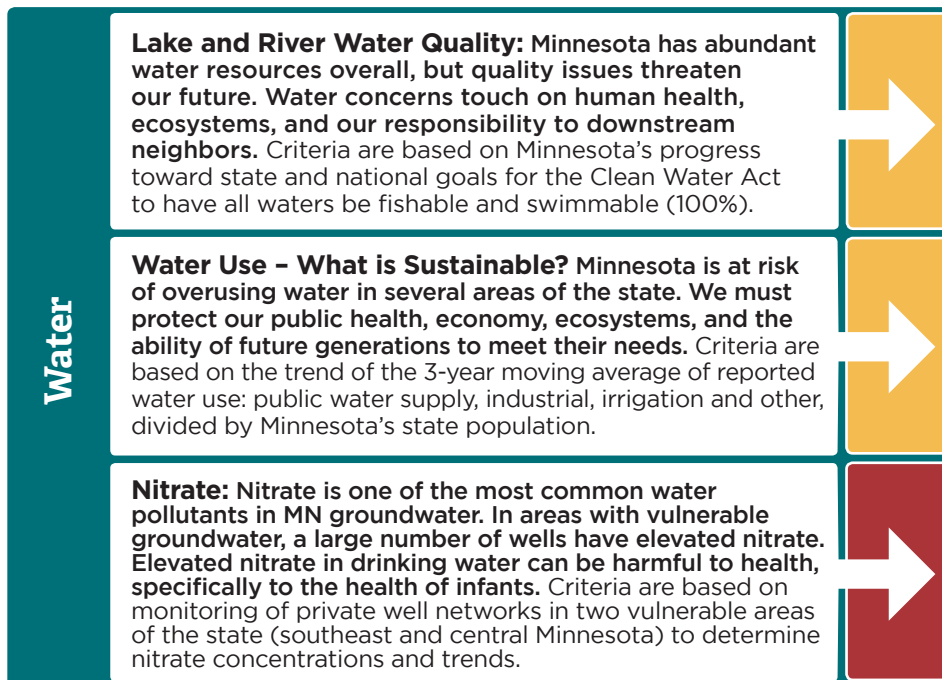
UP ARROW means things are **getting better**



FLAT ARROW means things are **about the same**



DOWN ARROW means things are **getting worse**



Air

Air Quality Index:

Minnesota is meeting national air standards. However, the state still experiences days when air quality is unhealthy for sensitive populations. Criteria are based on the percentage of days each year that exceed the air quality alert threshold.

Asthma and Public Health Impacts of Air Pollution:

Asthma emergency room visits, which are linked to poor air quality, disproportionately impact communities of color and those living in poverty. Criteria are based on Healthy People 2020 national target rates for asthma ER visits broken down into three age groups: 0-4, 5-64, 65+.

Transit Ridership:

The use of public transit is increasing, but ridership is not increasing at a rate that would achieve the goals of doubling ridership in the metro and meeting needs across the rest of the state. Criteria are based on passenger boardings recorded by public transit providers in Minnesota.

Energy

Minnesota's Renewable Electricity:

Minnesota is on track to meet its renewable electricity standard of 25%, however, the opportunity exists to go much further toward a 50% goal. Criteria are based on Minnesota's progress toward the Renewable Energy Standard of 25% renewable generation by 2025. Minnesota Statute 216B.1691

Minnesota's Household Energy Use:

Minnesota is making its homes more energy efficient; however, energy consumption continues to rise with the increasing use of air conditioning, appliances, and personal devices. Criteria are based on available Energy Information Administration (EIA) data and directional nature of the data presented.

Minnesota's Transportation Fuel Use:

Use of fossil fuels for transportation has been flat or growing the last six years. A steady decline in fossil fuel use is needed to achieve the state's greenhouse gas reduction goals. Criteria are based on the greenhouse gas reduction goals set forward in the Next Generation Energy Act.

Climate

Minnesota's Temperature:

Minnesota's climate is changing rapidly with increasing temperatures, especially in winter and at night, and with increasing frequency of extreme precipitation. Criteria are based on long term (since 1895) temperature data.

Greenhouse Gas Emissions:

Changes are occurring in Minnesota's climate with serious consequences for our environment and for human health and well-being. Criteria are based on progress toward meeting the Greenhouse Gas Emissions (GHG) reduction goals in the Next Generation Energy Act of 2007.

Cisco Fish Populations:

Cisco populations are declining with increasing temperatures, impacting walleye and trout which rely on them as a food source. Criteria are based on the standard measure of abundance (mean fish per net lifted) in surveyed cisco lakes.

Protecting, preserving, and restoring Minnesota's natural resources is critical to our economic vitality, health, and quality of life.

Healthy ecosystems contribute to the overall well-being of Minnesotans as well as state wildlife populations.



BLOOMINGTON, MN

Water

Clean water is critical to our health, economy and overall way of life in the Land of 10,000 Lakes. We all play a role in protecting our state's most precious resource for future generations. Our state is home to 69,000 river and stream miles, 10.6 million acres of wetlands, and trillions of gallons of groundwater resources. Minnesotans care deeply about preserving these resources. We recognize that water is fundamental to Minnesota's present and future quality of life and prosperity. However, Minnesota's population is growing and our environment is changing. This puts stress on water resources. We can no longer take for granted easy access to high-quality water for recreation, drinking, and commerce.

Minnesotans chose to invest in water. In 2008, we voted to increase sales tax to safeguard drinking water sources as well as to protect, enhance, and restore lakes, rivers, streams, and groundwater. In 2015, Minnesotans took another step toward improving water by enacting a law that protects water quality and habitat by requiring vegetation buffers on more than 100,000 acres of land next to water. Recognizing the need for a water ethic, Governor Mark Dayton declared 2016 the Year of Water, and asked Minnesotans to take a pledge to protect and preserve clean water for drinking, recreation, agriculture and for the thousands of other ways water serves a role in our daily life. Take the Water Pledge: www.mn.gov/governor/issues/wateraction

Ensuring that all Minnesotans benefit equally from our water resources and that no group is disproportionately impacted by water pollution or supply problems will lead to a stronger, healthier state for everyone. Going forward, population growth, activities on the land, and economic growth will continue to affect water quality and quantity. Balancing the needs of the state's many water users while protecting our diverse water resources is a challenge that requires a coordinated, interdisciplinary, and ongoing effort.

Minnesota has abundant water resources overall, but quality and availability issues threaten our future. Water concerns touch on human health, ecosystems, and our responsibility to downstream neighbors.



CAMBRIDGE, MN

INFRASTRUCTURE

The U.S. Environmental Protection Agency estimates that meeting Minnesota drinking water infrastructure needs will cost as much as \$7.4 billion over the next 20 years. Upgrading aging municipal wastewater treatment systems statewide is estimated at \$4 billion. Sixty percent of necessary upgrades are located in Greater Minnesota.



TWIN CITIES METRO

CHLORIDE

Chloride from winter deicing chemicals in runoff is an increasing concern for water quality, particularly because removal from water systems is prohibitively expensive. At high concentrations, chloride can harm fish and plant life. Some 349,000 tons of chloride in the form of winter deicing chemicals are applied in the Twin Cities metropolitan area each year.



KOOCHICHING COUNTY, MN

WETLANDS

The biggest threats to wetlands are practices on the land that cause degradation of water quality and natural vegetation and the invasion by exotic species. The overall goal at both state and federal levels is to maintain or even increase wetland acreage. Wetlands' water quality also suffers from pollutants and water volume overloading due to storm water in both rural and developed areas.



CONTAMINANTS OF EMERGING CONCERN (CEC)

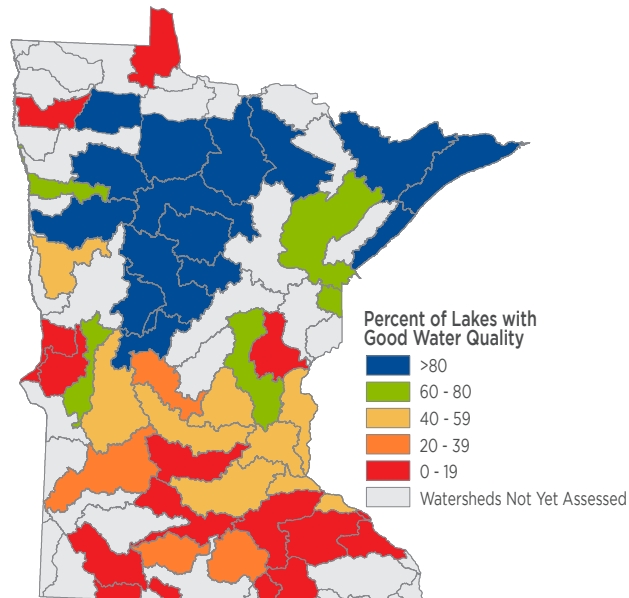
Individuals and industry use tens of thousands of chemicals in a vast array of products and applications, including household cleaners, medications, lawn care chemicals and personal care products. Some chemicals end up in places we never expected, including lakes and rivers. Many CECs have not been evaluated for the risks they pose to the environment, plants and animals, or humans.

Lake and River Water Quality

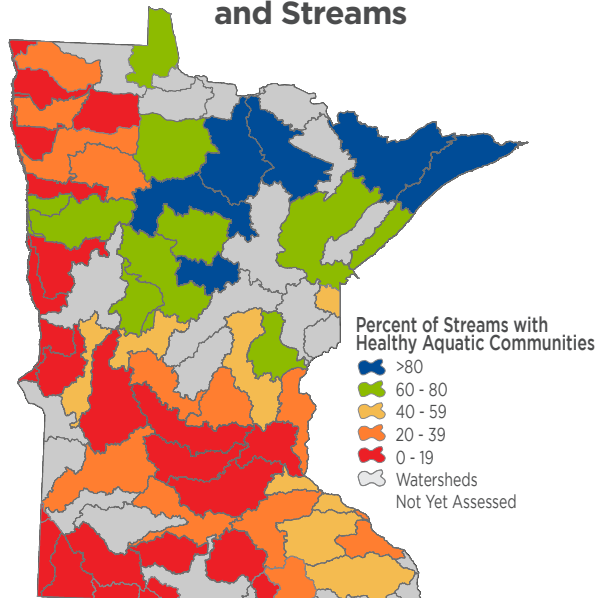


We have reduced pollution from sewers and industry in the last several decades. However, pollution from agriculture, lawns, and roads is increasingly found in our drinking water supplies, rivers, and lakes.

Water Quality in Lakes



Water Quality in Rivers and Streams



SOURCE: MPCA – Assessments through November 2016

Community Action:

Lake Volney — A local lake association has worked for decades to improve Lake Volney in Le Sueur County, near Le Center. They've taken on wetland restoration, buffer strips, stream bank stabilization, rain gardens, and annual cleanups, and they have collaborated with farmers to adopt beneficial practices. The lake went from algae covered in the 1990s to good water clarity in 2013.

60% of lakes and rivers meet water quality standards for fishing and swimming.

Do Your Part:

All Minnesotans need to do their part to improve water quality. The choices landowners make on their landscape determine whether it is able to hold the soil, absorb rainfall and filter nutrients. The choices we make today will affect future Minnesotans for decades to come. Engaging local communities (neighbors and upstream watershed residents) to make sure that everybody understands how their actions contribute to the downstream problem is a key strategy for addressing the water quality issues in the state.

Water plays a major part in Minnesota's culture, economy, and natural ecosystems. As residents, we want to know if our waters are healthy. Can we go swimming and eat local fish? Currently, the Minnesota Pollution Control Agency (MPCA) is testing the quality of nearly all Minnesota waters and is finding that about 40% do not meet basic water quality standards. Water quality information is used to determine if lakes and rivers are swimmable, fishable and if interventions are needed to improve water quality.

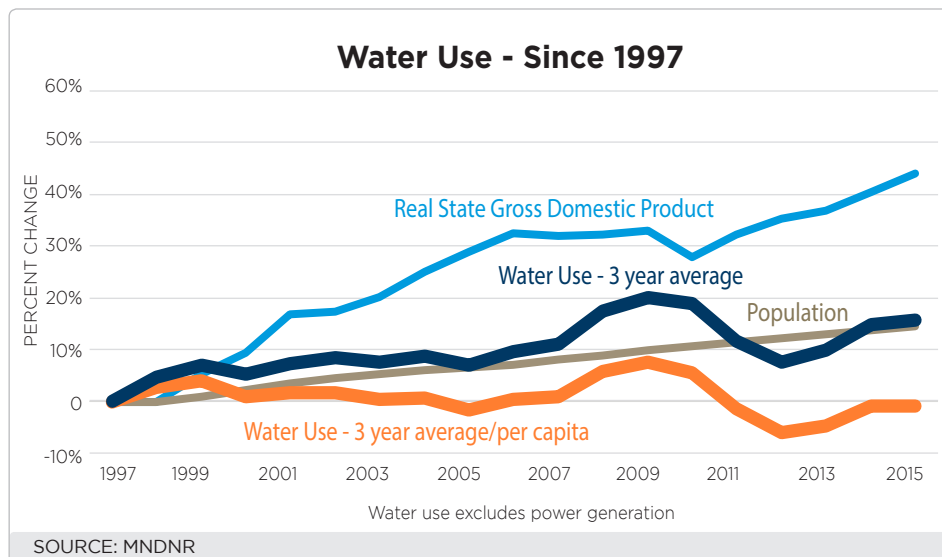
Excess nutrients and sediment threaten the health of many lakes and rivers in Minnesota. Phosphorus and nitrogen from fertilizers and chloride from road and water softener salt are significant sources of nutrient contamination that impair water quality and impact recreation. Activities on the land are responsible for generating these contaminants. For example, in watersheds dominated by urban and/or agricultural land, at most, half of the lakes fully support the standard for swimming because of phosphorus and resulting algae blooms.

Stream and river conditions — including the condition of fish and other organisms, and levels of nitrogen, phosphorus, and other pollutants — worsen as you move west and south in the state.

Sustainable Water Use

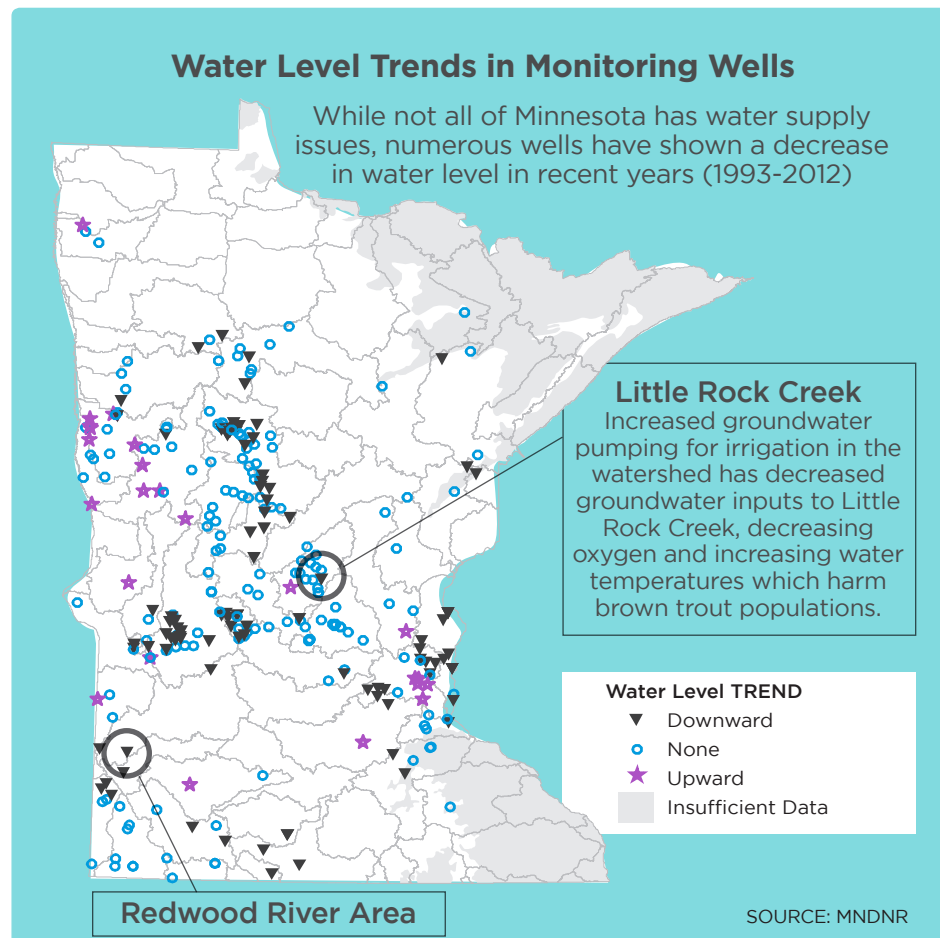


Minnesota is at risk of overusing water in several areas of the state. Sufficient water supply is vital to our public health, economy, and ecosystems.



Minnesota has abundant water resources, but water resources are not evenly distributed across the state. Over the last few decades, average water use per person has remained stable. However, the population has grown steadily, resulting in increased statewide water use over this time frame. Further, growth and development have not been evenly distributed across the state. This results in varying pressure on locally available water supplies. Parts of Minnesota, like the Redwood River area, face real challenges to meet water demand sustainably. Declining aquifer levels are causing water supply issues for communities, industry and wildlife areas along the Redwood River.

For some communities and regions of the state, surface water resources, ecosystems, and domestic water supplies may be at risk from increased use. Going forward, Minnesota's water supply systems will need to be resilient and flexible enough to meet ecosystem and community needs as we work to develop a clearer picture of how much water use is sustainable for Minnesota communities. Improving water efficiency and reducing waste are critical to providing this resilience.



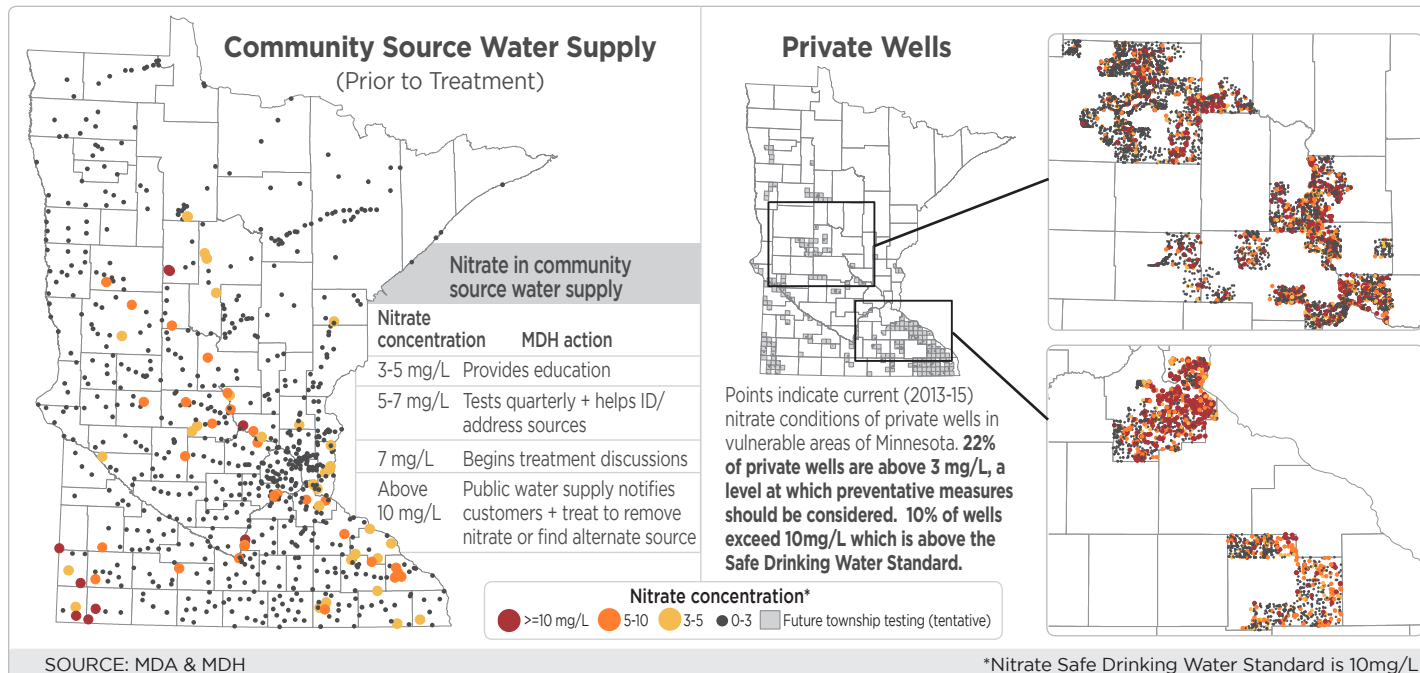
Do Your Part:

Fix leaky fixtures and minimize lawn watering through using different grass varieties, native plantings, or allowing lawns to go dormant during hot and dry weather. One alternative is fescue-blend grasses, which require about 70% less water than typical lawns.

Nitrate



Nitrate is one of the most common water pollutants in MN groundwater. In areas with vulnerable groundwater, wells are more likely to have elevated nitrate. Elevated nitrate in drinking water can be harmful to health, specifically to the health of infants.



Nitrate is one of the most common water pollutants in Minnesota's groundwater, affecting a large number of private wells and public water supplies. Septic tanks, fertilizers, and manure are major sources of nitrate pollution in Minnesota.

Approximately 20% of Minnesota's cropland overlies highly sensitive groundwater. Southeast and central Minnesota are especially vulnerable to contamination. Implementation of best management practices, like planting living cover on targeted high-risk areas, as well as using appropriate techniques for application of nitrogen fertilizer, can reduce nitrate in groundwater.

Monitoring drinking water for nitrate:

The Minnesota Department of Agriculture (MDA) designed the Township Testing Program to determine nitrate concentrations in private wells. The MDA identified townships that are vulnerable to groundwater contamination and have row crop production (see map), and prioritized

them for testing due to their increased risk. In areas with elevated nitrate, MDA will work with local communities to develop and implement strategies to reduce nitrate contamination. In a limited set of the most vulnerable parts of the state, application of fertilizer in the fall and winter will be restricted.

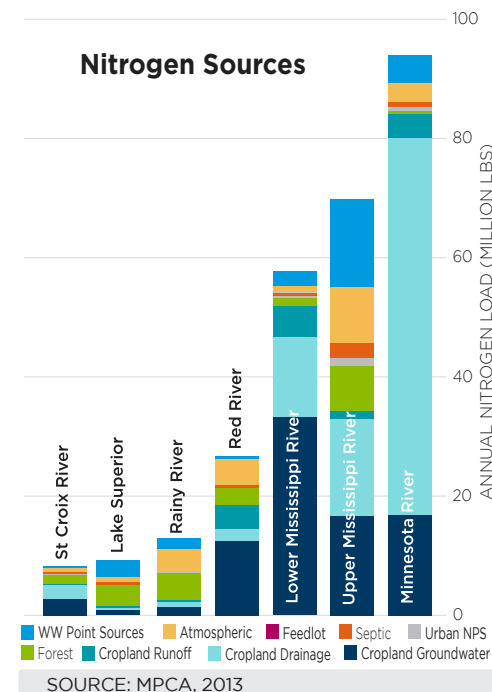
The Minnesota Department of Health monitors nitrate levels in community water supplies and works with Public Water Suppliers to try to prevent nitrate from exceeding drinking water standards through land use changes. If nitrate levels are too high, treatment systems need to be built.

Minnesota Agricultural Water Quality Certification Program (MAWQCP)

MAWQCP is a partnership between the State of Minnesota, the federal government, and Minnesota's network of soil and water conservation districts. Minnesota businesses, including Land O' Lakes, Inc., also partner with the program to protect our water resources. MAWQCP has certified more than 160,000 acres and spurred over 510 new best management practice implementations.



Nitrogen Sources



Land

Across Minnesota, how we use our land can have broad impacts. For example, how we build our cities and manage our crops can affect water, habitat, and air quality. Understanding the complexity of land use and management decisions is crucial to support thriving communities, protect species and ecosystems, and sustain economic growth.

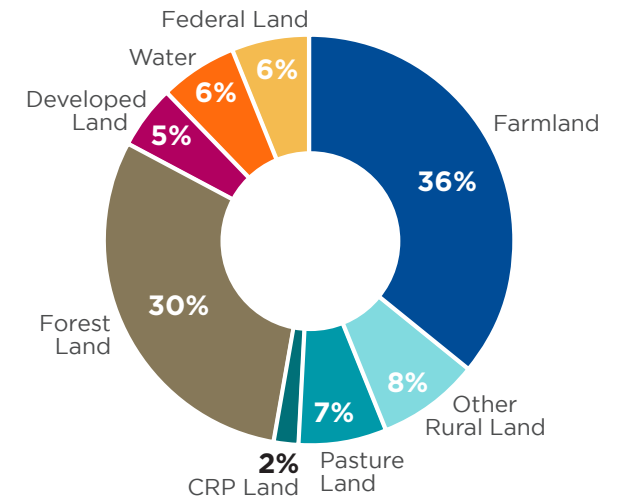
Humans have significantly altered Minnesota's ecosystems and habitats by using land for farming, forestry, mining, and to build cities and towns. Over the last 150 years, large areas of Minnesota's prairie, wetlands, and forests have been converted to pasture, cropland, and residential and commercial development. As a result, natural habitats have been reduced in size and quality and become fragmented, which in turn affects wildlife populations.

The development of land for housing, businesses, roads, and industry has reduced land available for resource-based activities such as agriculture, forestry, and recreation. How we dispose of our waste also impacts the land in terms of space needed to transport, process, and store waste, and our ability to contain contaminants.

We need to continue to improve our ability to use land wisely and efficiently and to minimize negative impacts of land development and conversion.

Minnesota Land Use/Cover in 2012

Total land area approximately 54 million acres



SOURCE: 2012 National Resources Inventory. USDA/NRCS

Since settlement, Minnesota's natural ecosystems have been developed and fragmented for human use. We can use our land more efficiently to better protect our ecosystems and water.



SAINT LOUIS PARK, MN

DENSITY

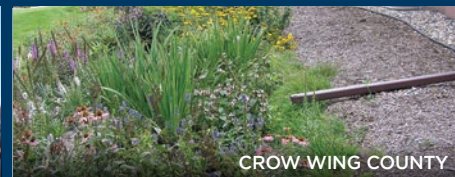
Steering growth to already urbanized areas, reuse of existing buildings and developed land, increased residential densities and more transportation options lead to development patterns that preserve the natural environment.



WORTHINGTON, MN

WORTHINGTON WELLS

Over 95% of highly vulnerable acres (147 acres) within the wellhead protection boundaries for the city of Worthington were protected by Pheasants Forever and other public and private partners to create habitat while also protecting drinking water resources. This land purchase also helped complete a wildlife habitat corridor stretching from Lake Ocheda to Lake Bella.



CROW WING COUNTY

GREEN INFRASTRUCTURE

Green infrastructure is a cost-effective, resilient approach to managing wet weather impacts that provide many community benefits. By keeping rain where it falls and mimicking natural hydrology, green infrastructure practices both minimize pollution reaching our lakes, rivers and streams, and recharge our groundwater.



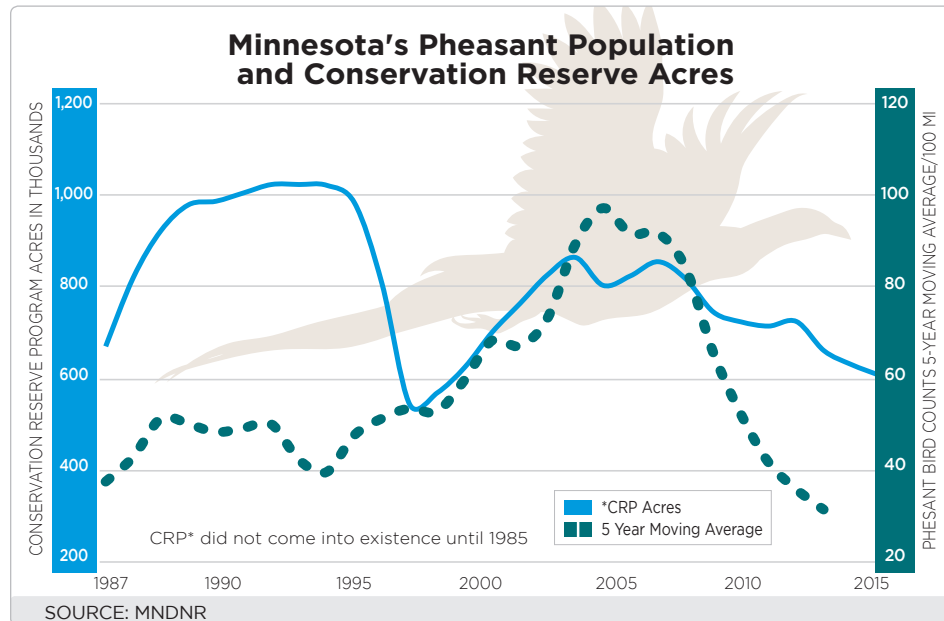
RECYCLING

Minnesota's recycling manufacturing industry is recognized as a national leader. In 2003, the industry supported more than 9,000 jobs and added \$2.98 billion to the state's economy. Recycling significantly reduces the amount of trash that goes into landfills.

Pheasants



Recent pheasant and other grassland bird population declines reflect significant prairie and grassland habitat loss.



Grassland birds are declining faster than any other group of birds in the United States. Major loss of grassland habitat in Minnesota has driven declines in pheasant populations, meadowlarks and other grassland species. This has been compounded by successive years of poor weather conditions. The quality of Minnesota's grasslands has also declined as trees and non-native invasive species encroach on high quality grassland habitats.

One of the contributing factors to prairie habitat loss is the conversion of grasslands for agricultural use. The August Roadside Survey Index (which counts birds per 100 miles) is the long-standing measure of Minnesota's pheasant population. Similar to other grassland-dependent wildlife, the pheasant population has seen a sharp decline in the past several years. This has happened in tandem with a major loss of grassland habitat as pasture and land in conservation programs have been converted to row crops and, to a lesser extent, urban land.

*The US Department of Agriculture uses the Conservation Reserve Program (CRP) to pay eligible farmers who remove environmentally sensitive fields from agricultural production by planting trees, grasses and wildflowers to improve environmental quality for ten to fifteen years. CRP acres are for the pheasant range in Minnesota.

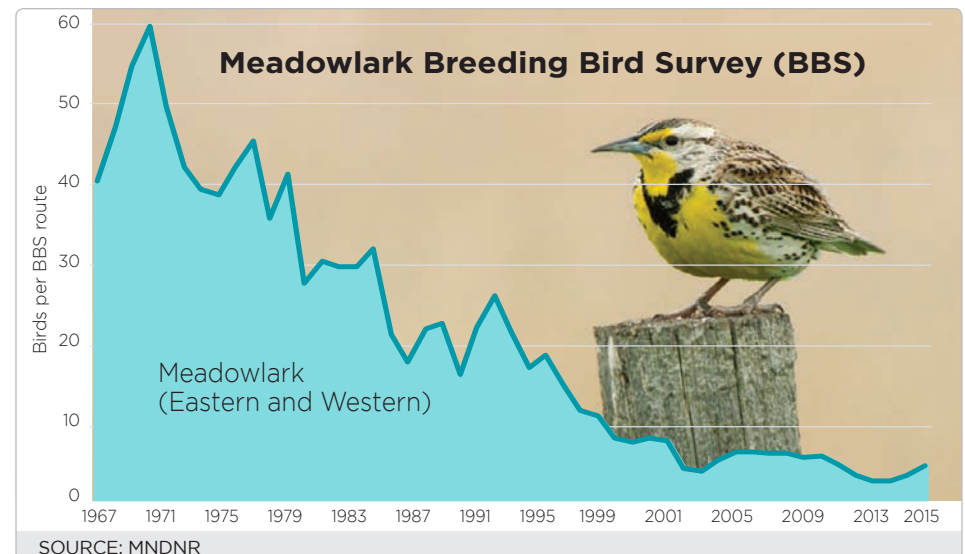
Meadowlarks

Eastern and Western Meadowlarks can be found along roadsides, grasslands, croplands, weedy fallow fields, and mixed grasslands/shrublands.

Loss of suitable habitat is a significant factor in meadowlark population declines. This is true of many grassland birds.

Disturbances—including mowing, spraying, burning, farm tillage, grazing, field turnaround spraying and vehicle or equipment encroachment—during peak nesting months (May, June, July) significantly lower reproduction of meadowlarks and other grassland birds.

Prairie once covered one-third of Minnesota. Now less than one-percent of native tallgrass prairie remains. It is North America's most endangered habitat.

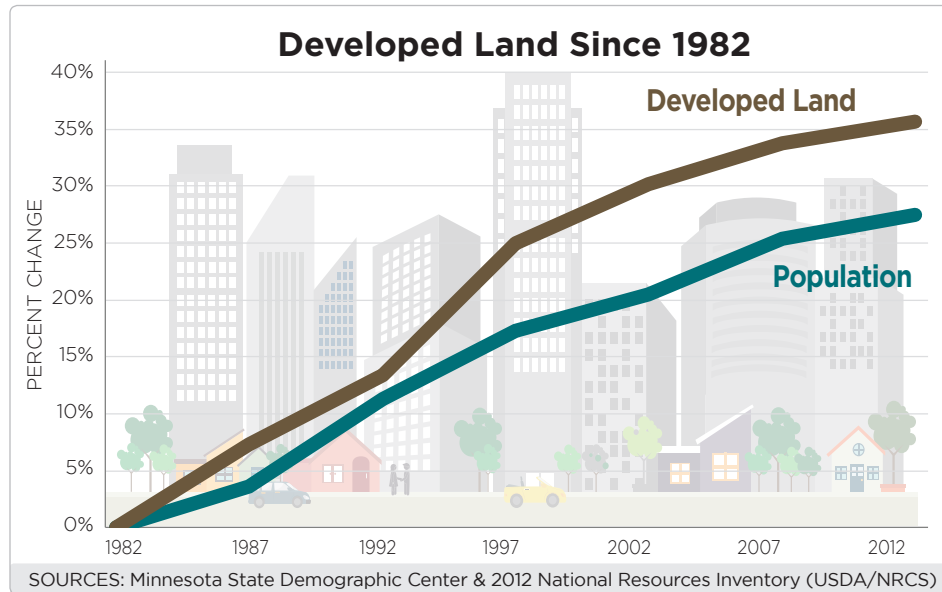


Land Conversion



Over time, our land conversion per person has increased, resulting in a higher rate of land conversion of prime farmland, forest land, wetlands, and wildlife habitat.

Approximately 35% of land in Minnesota developed between 1982 and 2012 was prime farmland.



Land conversion refers to how much land we use as our cities and towns grow to support larger populations. This land conversion results in the transformation of open space (natural areas/ecosystems), farmland, and forest land to developed or urban land uses.

As we grow, both in terms of population and the economy, we need room for jobs, recreation and entertainment, shopping, parking, transportation, storage, government services, religious and cultural opportunities, waste handling, and education. However, we can develop land more efficiently than we do today through, for example, more compact development patterns, increased residential densities, reuse of existing buildings and developed land, and more transportation options (decreasing land demands for roads and parking lots).

Efficient use of land can provide many economic, social, and environmental benefits including improved accessibility, increased efficiency in providing utilities and public services, transportation cost savings, open space preservation, reduced per capita pollution emissions, and fewer impervious surfaces (such as pavement).

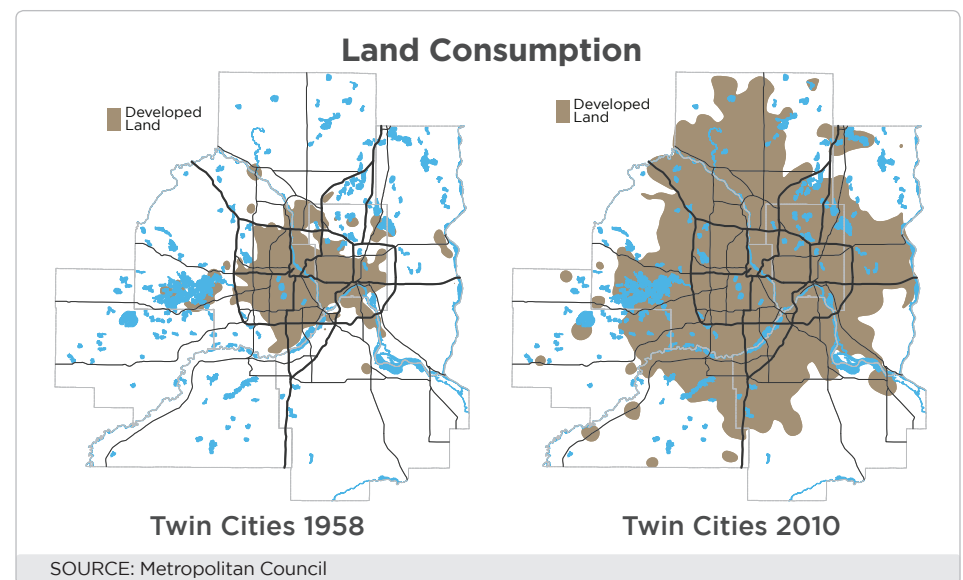
Planning Focus:

Communities in the Twin Cities Metropolitan Area are currently engaged in comprehensive plan development. The Metropolitan Council's *Thrive MSP 2040* promotes growth in already urbanized areas and encourages comprehensive plans to locate new developments in ways that preserve and benefit from the natural environment, thereby reducing development pressures that endanger natural resources. Communities are also encouraged to partner to conserve, maintain, and restore natural resources identified in local natural resource inventories.

Success Story:

Dakota County Farmland & Natural Areas Program

The Dakota County Farmland & Natural Areas Program works with willing landowners to protect farmland and natural areas by purchasing permanent agricultural conservation easements. The landowner retains the rights to use, rent, transfer, or sell the land; however, the property within the easement cannot be developed. To date, a total of 10,781 acres have been protected.



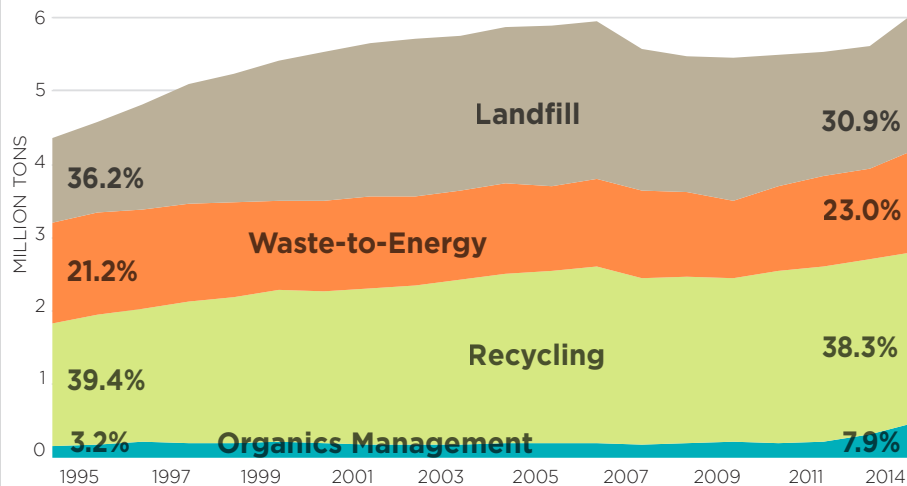
Recycling



About one-third of our waste is still sent to landfills. More of this waste could be recycled.

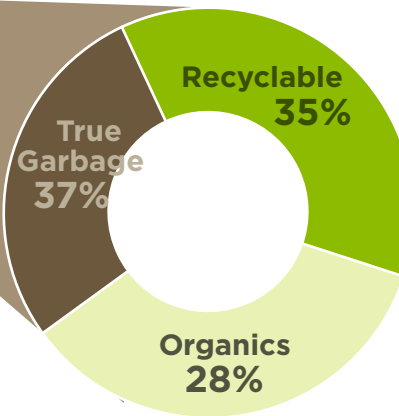
Every year, each American throws out about **1,200 pounds of organic garbage** that can be composted.

Waste Management in Minnesota, 1995 - 2014

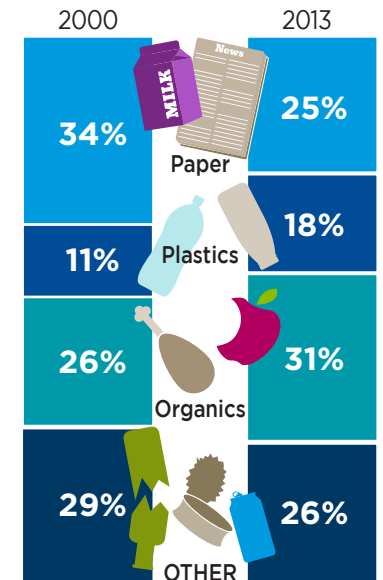


SOURCE: MPCA

More than 63% of waste sent to landfills and waste-to-energy could be recycled or composted



Composition of waste sent to disposal facilities



Minnesota's recycling programs are among the nation's most successful. From 2012 to 2013, Minnesota's combined recycling and composting rate increased from 45.6% to 46.9%. In 2013, over 2.7 million tons were recycled, or composted, an increase of over 108,193 tons from 2012.

Recycling and composting add significant value to Minnesota's economy while protecting our environment. According to a Statewide Waste Composition study, more than 63% of Minnesota trash is made up of paper, plastic, metal, glass, organics, and other materials that could be collected for recycling. That equals about 1.2 million tons of recyclable materials thrown away every year which is worth \$285 million.

In 2014, the Legislature increased the recycling goal (recycling and organics management) for counties in the Twin Cities metro area to 75% (from 50%) of the waste they generate by 2030. The Greater Minnesota counties' goal remains unchanged at 35%. Citizens, businesses, and corporations will play a critical role to meet Minnesota's 2030 goals.



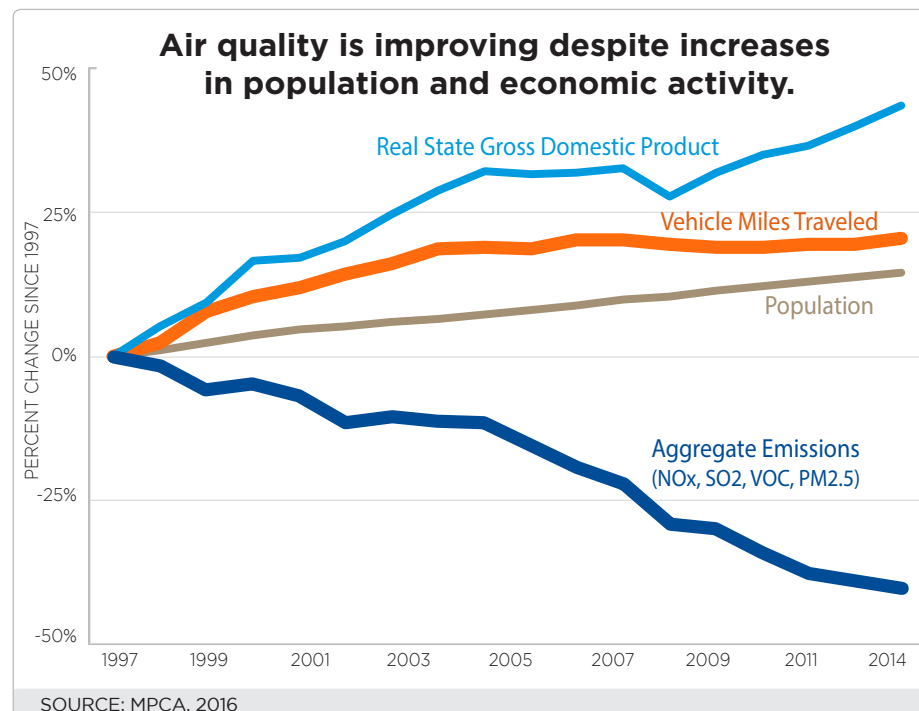
Saint Paul Hotel

The historic Saint Paul Hotel in the heart of downtown Saint Paul has a long-standing commitment to environmental sustainability. The hotel instituted a program to reduce waste and increase recycling. In the program's first month, it diverted almost 52,000 pounds (26 tons) of food waste. **It's estimated the program will divert over 600,000 pounds of food and other compostable materials every year and save the hotel over \$20,000 per year.**

Air

Today, much of the air pollution in Minnesota originates from smaller, more diffuse sources such as cars, trucks, tractor-trailers, small businesses, and residential wood burning. Individually, each of these sources may not produce much pollution, but together they become a major concern for public health. Addressing these sources will require new, innovative strategies that move beyond traditional regulatory programs. Through increased community outreach, voluntary programs, and partnerships, we must all work together to achieve future emissions reductions from these small, widespread sources.

Air pollution affects everyone, but some groups experience greater impacts than others, including the elderly, children with uncontrolled asthma, and people with pre-existing heart and lung conditions. In the Twin Cities, people living in poverty and in communities of color tend to have higher rates of pre-existing heart and lung conditions that can lead them to disproportionately feel the impacts of air pollution on their health. Continuing to reduce the level of these pollutants will not only improve public health and address health disparities but will also help our economy by avoiding air pollution-related health costs like medical expenses and productivity losses due to missed school or work days.



Non-regulated sources make up the majority of emissions in Minnesota



TWIN CITIES

ONROAD VEHICLES 30%

On-road vehicles include passenger cars and trucks, semi-trucks, and buses.



JORDAN, MN

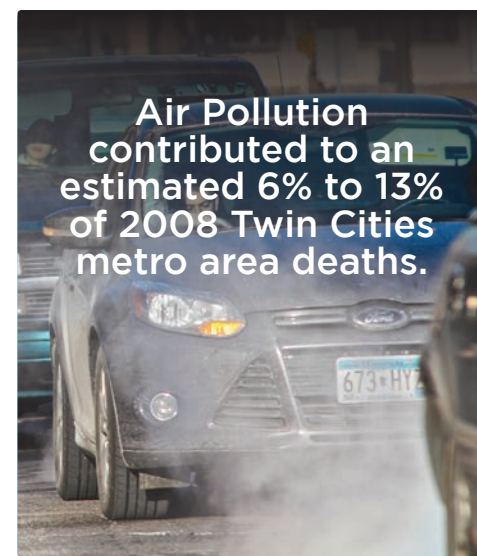
OFF-ROAD VEHICLES 20%

Off-road vehicles include those vehicles used in construction and agriculture, yard and garden equipment, recreational vehicles, trains, planes, and boats.



RESIDENTIAL AND COMMERCIAL 25%

Residential sources of air pollution include home heating, garbage burning, and wood burning for heat or recreation. Commercial sources of air pollution include gas stations, char-broilers, dry cleaners, and auto body shops.

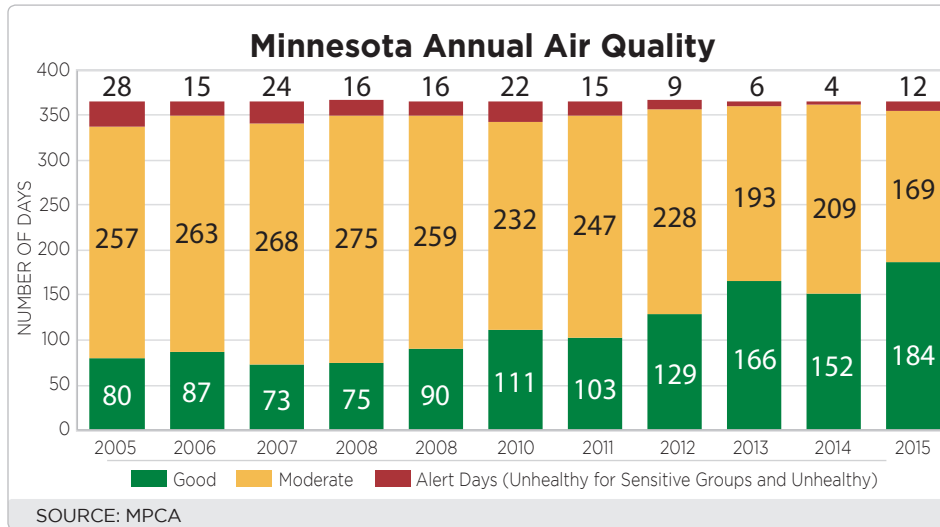


Air Pollution contributed to an estimated 6% to 13% of 2008 Twin Cities metro area deaths.

Air Quality Index



Minnesota is meeting national air standards. However, the state still experiences days when air quality is unhealthy for sensitive populations.



Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution
Unhealthy for Sensitive Groups (USG)	101 to 150	Members of sensitive groups may experience health effects, including people with asthma, children, older adults, and people who are doing heavy outdoor work or exercise.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects



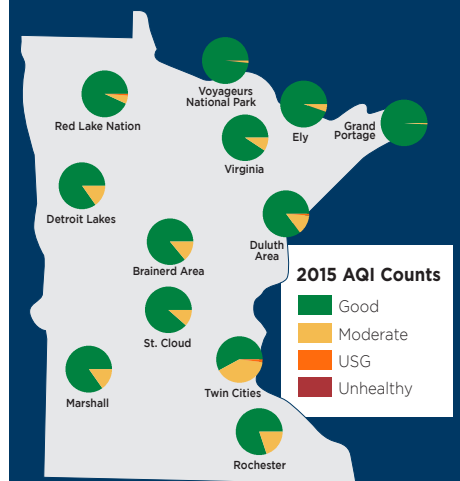
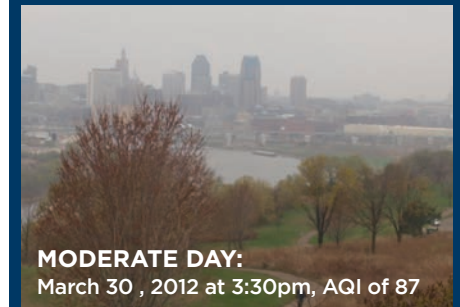
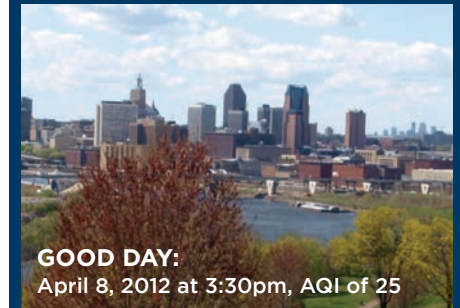
Be Air Aware: Find out if you should be concerned each day by signing up for alerts, checking in the newspaper, or downloading the mobile app. Learn steps you can take to reduce emissions. www.beairawaremn.org/

When we breathe in polluted air, particles enter our lungs and can enter our bloodstreams and cause health problems, especially for the lungs and heart. People with asthma and other health conditions are particularly sensitive to poor air quality.

The quality of the air is always changing due to weather patterns and can differ across the state. Air quality alerts let the public know when they should take precautions because conditions might be a concern for them. Paying attention to these alerts and taking action to limit exposure can help people prevent negative health effects.

We make decisions every day that affect air quality, including driving, using gas-powered lawnmowers, and having fires in our backyards. Collectively, we can improve air quality by replacing car trips with riding mass transit, bicycling, and walking. Also, substituting cleaner products and appliances, such as using electric or push mowers in place of gas-powered ones, can make a big impact on air quality.

Air quality can be different in different parts of the state. The Metro Area experiences the most days with air quality issues.



SOURCE: MPCA

Asthma and Public Health Impacts of Air Pollution



Asthma emergency room visits, which are linked to poor air quality, disproportionately impact communities of color and those living in poverty.

Communities living in poverty and communities of color are disproportionately vulnerable to the impacts of air pollution.

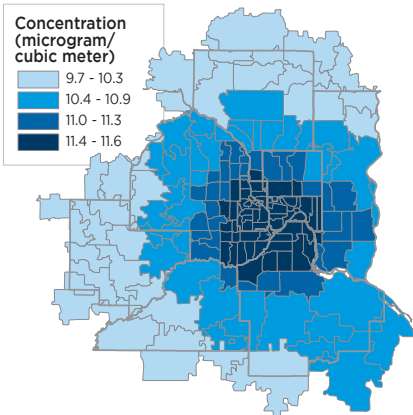
Some communities in Minnesota are more impacted by asthma than others. Children in the Twin Cities metro area go to the ER for asthma at a rate nearly twice as high as for children living in Greater Minnesota. Within the Metro Area, zip codes with higher proportions of people living in poverty and people of color have asthma hospitalization rates for children that are 4 times higher than the rest of the state. Efforts to reduce air pollution are one important part of addressing these disparities.



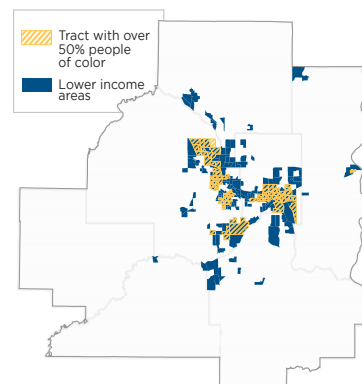
Minneapolis mother Minke Sundseth uses the Air Quality Index (AQI) alert system daily while managing her eleven-year-old son Oliver's asthma condition. Oliver runs track and field but his asthma can be triggered by poor outdoor air quality. AQI alerts to Minke's phone and e-mail enable her and her husband to make proactive decisions that help minimize the chance of Oliver having an asthma attack. Tracking AQI alerts can be a useful part of a person's asthma action plan.

Twin Cities Metro Area

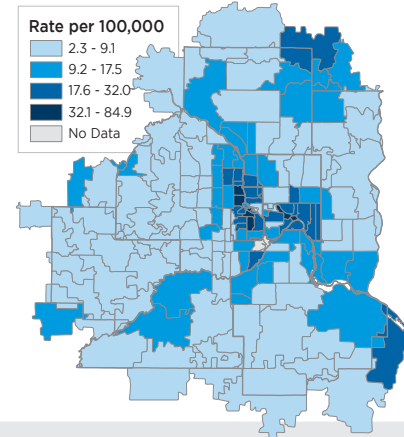
Annual average fine particulate matter concentrations by zip code



Census tracts with lower income populations and communities of color



Asthma ER visit rates attributable to fine particulate matter



SOURCE: MDH 2006-2010 data, MPCA 2008 and 2010 data

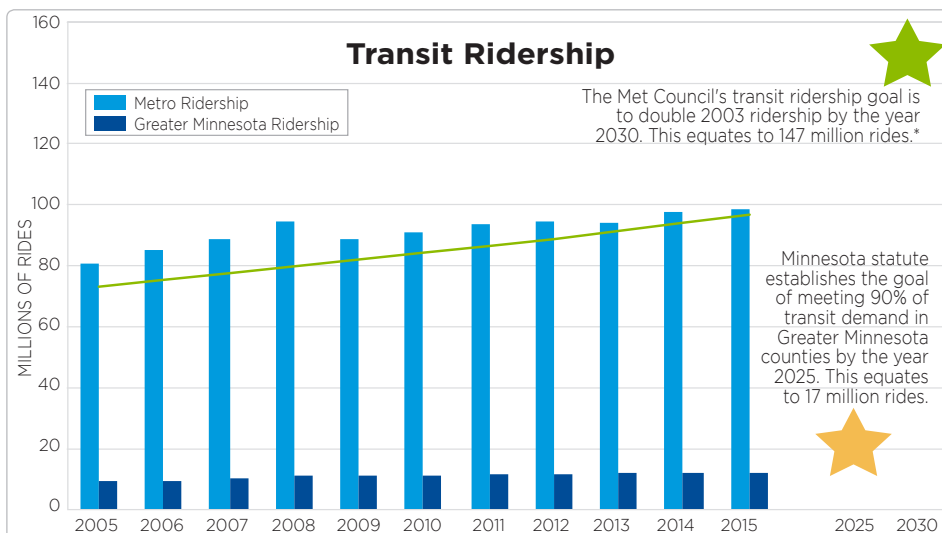
Breathing polluted air can cause a variety of health problems. While air quality in Minnesota currently meets federal standards, even low and moderate levels of air pollution can contribute to serious illnesses and early death. It is estimated that in 2008 approximately 6 to 13 percent of all residents who died and about 2 to 5 percent of all residents who visited the hospital or emergency room (ER) for heart and lung problems in the Twin Cities did so partly because of fine particles in the air or ground-level ozone. This roughly translates to about 2,000 deaths, 400 hospitalizations, and 600 emergency room visits.

Everyone can be affected by breathing polluted air, but those with preexisting health conditions, the elderly, and children with uncontrolled asthma are affected more than others. While there are only small differences in air pollution levels between zip codes in the Twin Cities, some zip codes have much greater rates of emergency room visits for conditions like asthma. These zip codes include communities with larger populations of people of color and residents living in poverty. Because these populations already have higher rates of heart and lung conditions, they experience more hospitalizations, asthma emergency room visits, and death related to air pollution. If we can better prevent heart and lung diseases, and help children control their asthma, we can help these populations avoid hospitalizations, emergency room visits, and live longer healthier lives. Poor outdoor air quality is one factor that can exacerbate the uneven distribution of these health impacts among Minnesota communities.

Transit Ridership



The use of public transit is increasing, but ridership is not increasing at a rate that would achieve the goals of doubling ridership in the Metro and meeting needs across the rest of the state.



*Met Council's ridership goal is based off the 2030 Transportation Policy Plan (TPP) that has since been updated to the 2040 TPP. The ridership goal was not included in the 2040 TPP, the Council will be reassessing this goal in a future update of the TPP.

SOURCE: MNDOT



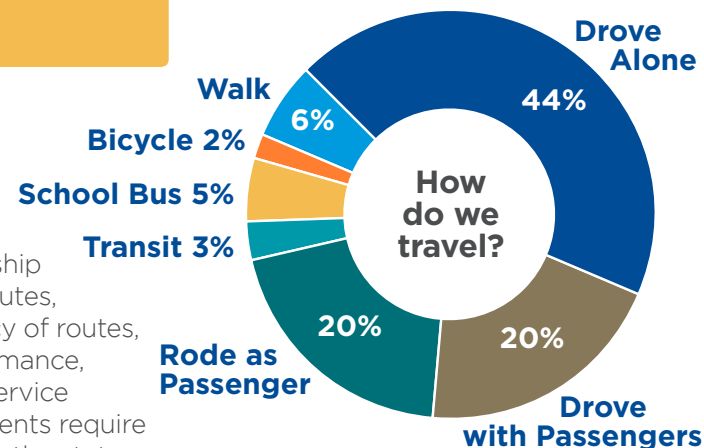
Increasing public transportation options and improving access to public transportation can improve air quality by reducing demand for automobile travel. Air quality improvements are particularly needed in areas with traffic congestion. Public transit, such as light rail lines and bus routes, can also improve health equity by providing safe, convenient, reliable and affordable access to jobs, schools, healthy food options, parks and other opportunities for physical activity.

What Needs to Happen:

Increasing transit ridership requires adding new routes, increasing the frequency of routes, improving route performance, and establishing new service areas. These improvements require additional funding from the state as well as federal and local partners. Transit agencies can further maximize the impact of the available funding by incorporating new technology and improving operating procedures where feasible. Cities and counties can also increase ridership by supporting development around transit to ensure that people live where they have access to the transit system.

Success Story:

The Twin Cities metropolitan area is one of only five regions nationwide to win competitive funding from a U.S. Department of Transportation program aimed at reducing congestion. The Kenrick Park & Ride (Lakeville, MN) was built as part of this project, and is now a hub for express bus service. The park and ride serves 500 riders a day on average, each of whom save about \$17/day on transportation costs and reduce their personal carbon footprint by 18%.



SOURCE: Met Council
2010 Travel Behavior Inventory

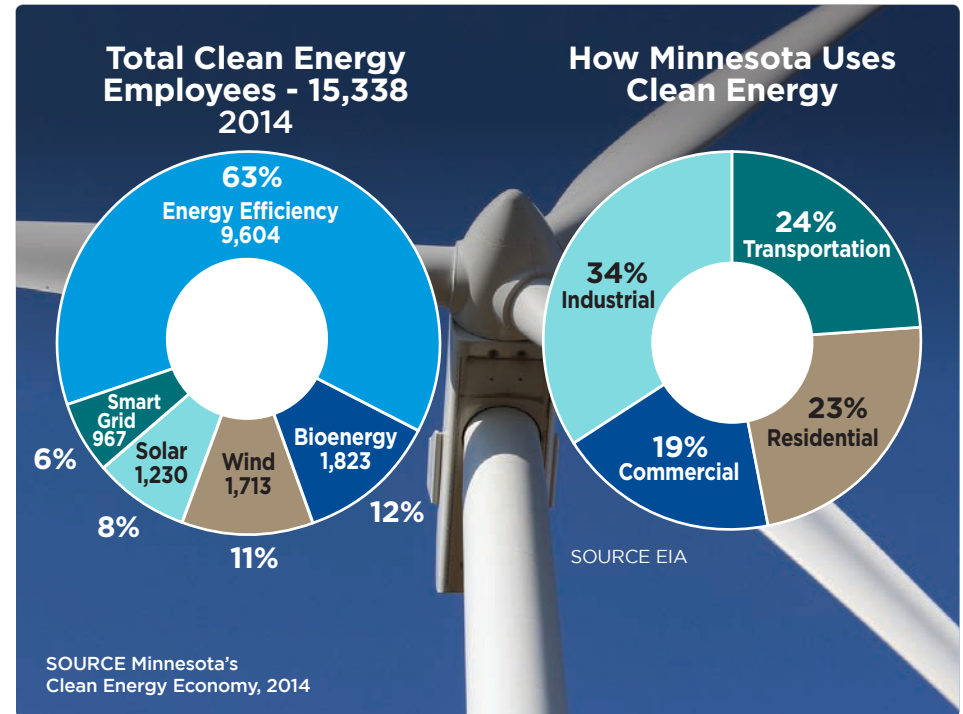
ONE BUS carries as many commuters as 40 single occupancy vehicles



Energy

Our energy system affects all of Minnesota's natural resources. Minnesota's energy sector includes electric and natural gas utility systems, pipelines that transport fuel as well as fuel used for air and land transportation of people and goods. New electric generation and transmission infrastructure, along with pipelines and transportation infrastructure, impacts land and habitat; power plants are the largest users of water statewide; fossil-fuel powered cars and electricity pollute our air. The majority of Minnesota's energy still comes from fossil-fuels, and this production represents the state's biggest source of greenhouse gas emissions. Further, use of fossil-fuels releases other harmful pollutants that impact human health and wildlife. However, the opportunity to increase in-state renewable energy sources is significant. Transitioning the state's energy use and production to lower carbon sources is a high priority for meeting climate goals and reducing the impact of the energy sector on Minnesota's natural resources.

There are over 15,000 employees in the state of Minnesota that spend the majority of their time on clean energy.



Minnesota's clean energy transition holds great economic and environmental opportunities for the state.



CLEAN ENERGY JOBS

Minnesota's growing clean energy economy sustains local jobs and attracts investment. These clean energy businesses employ workers and generate revenue directly from products or services. They use less energy to provide the same service, or produce heat, power, or fuel from renewable sources of energy.



ENVIRONMENTAL AND HEALTH BENEFITS

Reducing reliance on fossil fuels can provide significant health and ecosystem benefits. Burning coal and gasoline emits chemicals into the air that contribute to asthma attacks, heart attacks as well as lung and heart disease. Air pollution can also damage vegetation, trees, and crops.



COMMUNITY ENERGY PLANNING

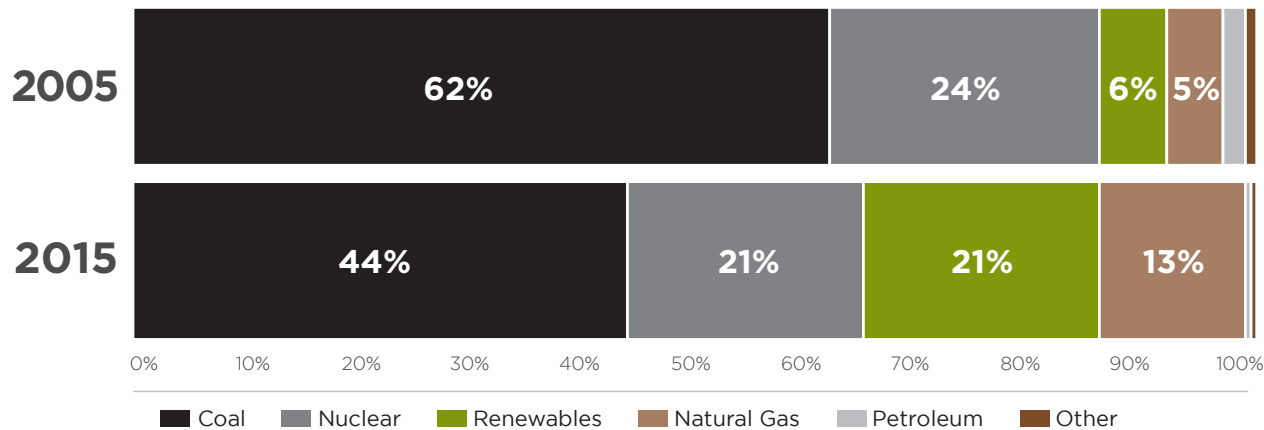
Engaging communities in energy and climate planning can not only help Minnesota achieve its statewide greenhouse gas emission reduction goals, protect our natural resources, and provide consumers with tools to make wise choices regarding energy use and generation but can also help communities weather the impacts of climate change.

Minnesota's Renewable Electricity

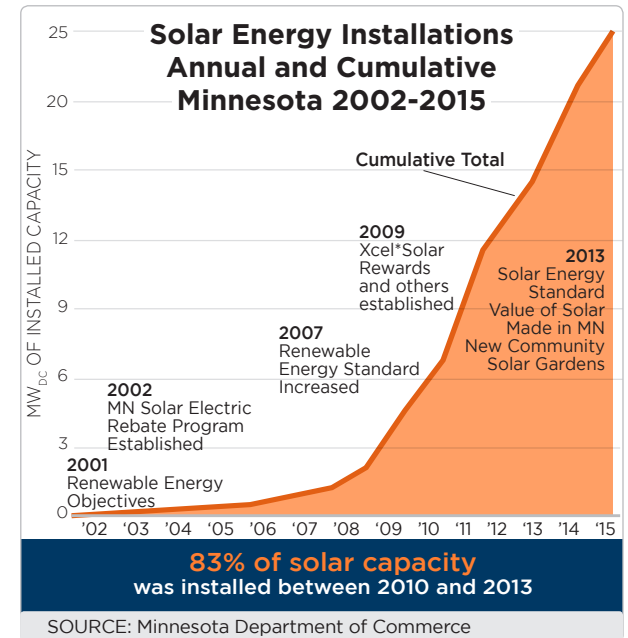
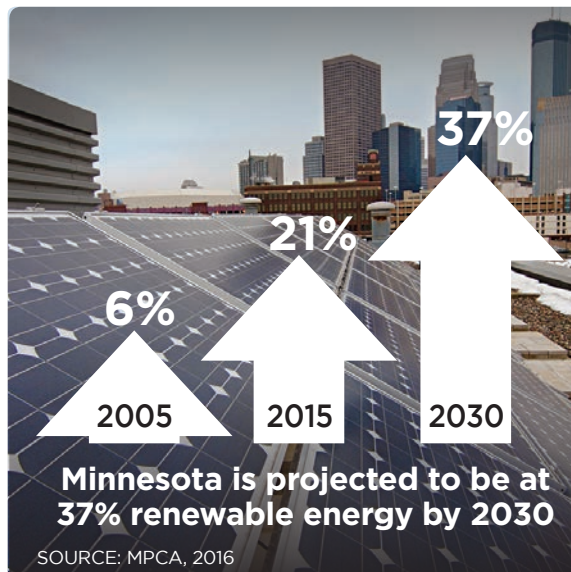


Minnesota is on track to meet its renewable electricity standard of 25% by 2025, however, the opportunity exists to go much further toward a 50% goal.

Minnesota is decreasing the use of coal and increasing the use of renewable energy to generate electricity



Minnesota has no fossil fuel resources, but there are abundant renewable resources in the state, including wind, solar, and biomass. The state passed a renewable electricity standard (RES) in 2007 requiring that 25% of the state's electricity be generated by renewable energy by 2025. In 2015, Minnesota ranked seventh in the nation in net electricity generation from wind energy. Making use of local resources creates local jobs while also reducing the air and water pollution that results from burning fossil fuels. The prices of solar and wind energy have plummeted in recent years with advances in technology and economies of scale, while the cost of coal has increased with the need for environmental controls. While not a current goal for the state, several recent studies show that a 50% renewable energy goal by 2030 is possible and could benefit the economy and the environment.



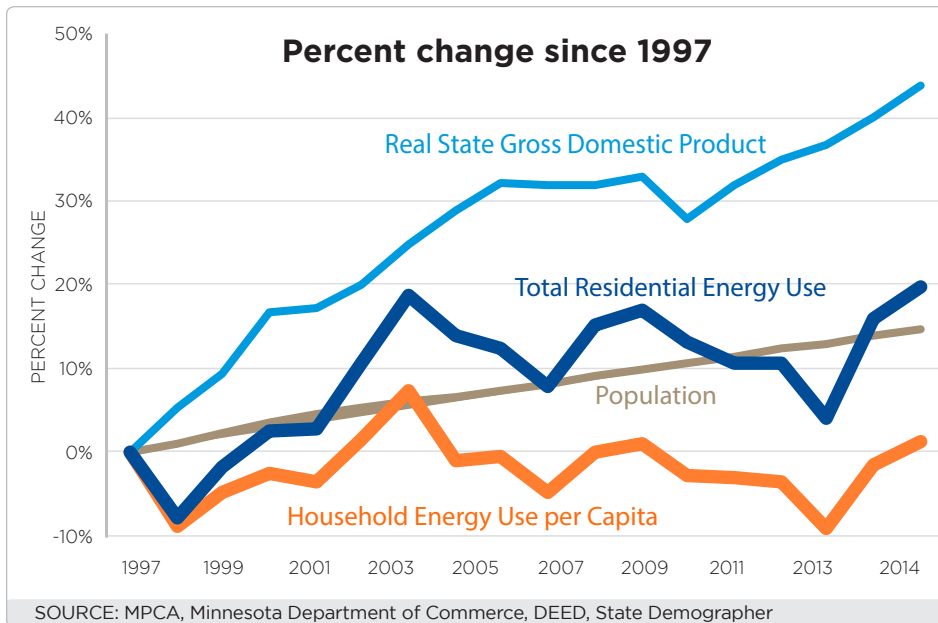
Do Your Part:

- Utility customers can sign up for voluntary green power programs which enable them to purchase renewable energy that's generated in excess of a utility's state mandates.
- Where available, some consumers can subscribe to a "Community Solar Garden" which is an alternative to installing solar panels on their own property.
- Consumers can have a solar site assessment to determine if their home or business is right for installation of solar photovoltaics.

Minnesota's Household Energy Use



Minnesota is making its homes more energy efficient, however energy consumption continues to increase with the growth in air conditioning use, appliances, and personal devices.



Households consume energy in a variety of ways, potentially using multiple fuel sources, including natural gas, propane, and electricity. In fact, 21% of the total energy used in Minnesota is consumed in our homes. Homes are more energy efficient today than ever before due to advances in heating and cooling systems, weatherization technology, and more efficient lighting. Appliances like refrigerators more than doubled in efficiency between 1990 and 2014. However, energy use to power appliances and electronic devices has grown, increasing overall household energy use. Greenhouse gas emission reductions can be achieved at a greater pace if Minnesota expands its energy efficiency resource standard as well as enables communities to adopt stretch codes for commercial and residential buildings.



Refrigerators have gotten 117% more efficient since 1990

Success Story:

Minnesota established a Conservation Improvement Program (CIP) in 2007 that set a goal of 1.5% per year decrease in the amount of electricity sold and a 1% decrease in the amount of natural gas sold. This is met through the participation of over 180 Minnesota utilities that provide technical assistance and financial incentives to their customers.



49%

The increase between 2000 and 2014 in the number of workers who spend the majority of their time advancing energy efficiency.

\$85 Million

In 2014, utilities invested over \$85 million to help their residential customers save electricity and natural gas.

\$360 Million

estimated electric utility bill savings over the life of household efficiency projects installed in 2014.

Equity:

High costs from energy inefficient homes disproportionately affect low-income individuals. The financial burden of inefficiencies stresses already tight resources for homeowners and renters. Programs such as the statewide Low-Income Home Energy Assistance Program (LIHEAP) and the Weatherization Assistance Program (WAP) can help income-qualifying consumers manage their utility bill costs and overall energy consumption. Additionally, access to renewable energy programs and technologies can help these consumers reduce their electric or natural gas utility costs.



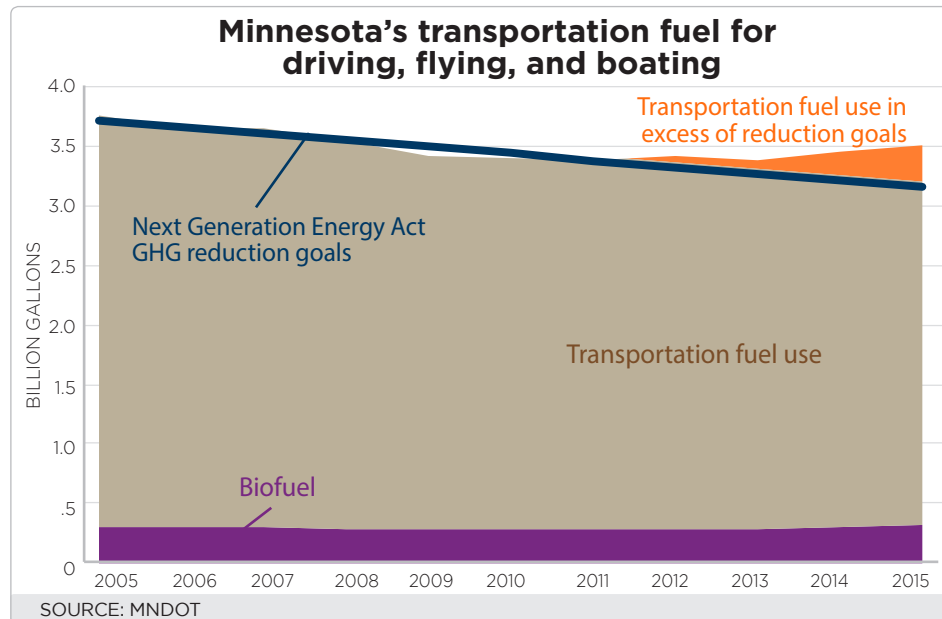
Do Your Part:

Home energy audits can help homeowners improve efficiency and learn about the best options for reducing energy use and utility bills in their homes. Audits help identify actions like adding insulation, sealing air leaks, installing high-efficient LED lights, and using a programmable thermostat.

Minnesota's Transportation Fuel



Use of fossil fuels for transportation has been flat or growing the last six years. A steady decline in fossil fuel use is needed to achieve the state's greenhouse gas reduction goals.



Transportation fuel use in Minnesota has increased over the last two years as low gas prices and a strong state economy increased demand. Although partially offset by more fuel-efficient vehicles, this increase was enough to push total transportation fuel use to its highest level since 2008. A significant, long-term reduction in transportation fuel use requires both continued improvements in fuel economy, consumers choosing the most fuel-efficient vehicle type for their needs, and an expansion of travel alternatives that burn less fuel than driving alone.

Use of alternatives such as transit, carpooling, bicycling and walking increases as facilities and services improve and communities develop in ways that enable people and destinations to locate closer together.

Minnesota is a leader in biofuels, which account for 8 to 9% of the state's total transportation fuel use. Blended with fossil fuels, biofuels can reduce air pollution, create jobs, add value to agriculture products, and reduce our dependence on foreign oil.

Success Story:

Electric Vehicles (EVs) are powered by electricity (via battery) instead of by fossil fuel burning combustion engines. EVs have several advantages. They have no tailpipe emissions and benefit from lower operation and maintenance costs. In addition, they reduce greenhouse gas emissions that contribute to climate change. With renewable-based grid electricity, EVs offer a significant reduction of greenhouse gas emissions relative to conventional vehicles. Currently, 2.5% of new cars sold in Minnesota are some type of electric or hybrid electric vehicle.



Fuel Efficiency over time

The number of vehicle **miles traveled per gallon in Minnesota increased** from less than 17 in 2002 to nearly 19 today. For every 1 mpg in additional fuel economy, total fuel use is reduced by approximately 170 million gallons per year.



The number of vehicle **miles traveled per person in Minnesota decreased** from 10,420 in 2004 to 10,098 today.

For every 100-mile reduction in Vehicle Miles Traveled (VMT) per capita, total fuel use is reduced by approximately 25 million gallons per year.

SOURCE: Minnesota Department of Transportation

Climate

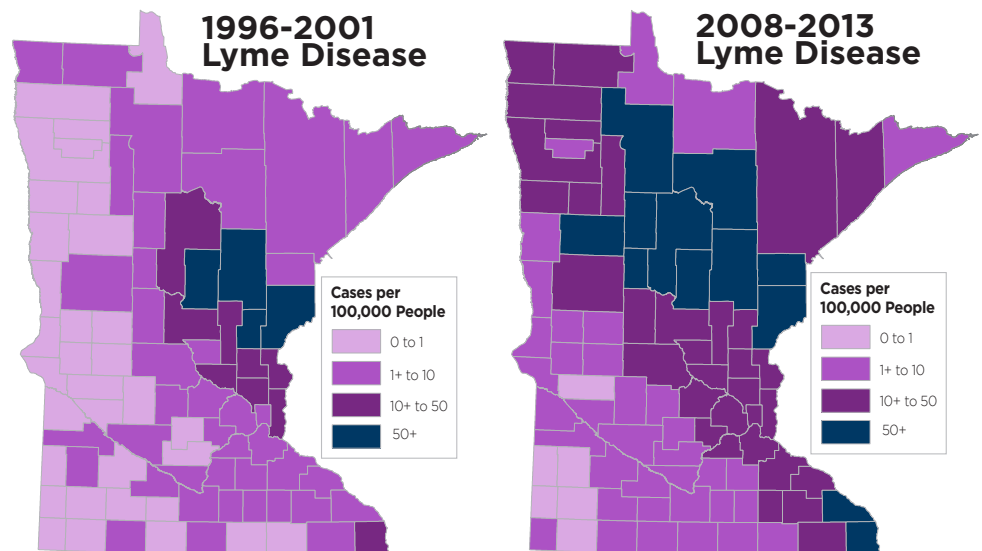
The world is becoming warmer, and Minnesota's climate is changing significantly. Communities are already experiencing increasing temperatures and more frequent extreme rain events. The state as a whole is facing costly infrastructure damage, loss of winter tourism, as well as a cascade of effects on agriculture, natural resources, and wildlife. To help stabilize the climate, Minnesota needs to continue to reduce greenhouse gas emissions by using fewer fossil fuels and protecting the carbon stored in trees and soils. Action to mitigate climate change requires ongoing efforts at global, federal, state, community, and household levels.

Addressing climate change is a smart investment. It will lead to a safer and more environmentally stable future for Minnesota. However, the complex and global nature of climate change means that these important actions may not result in noticeable climate improvements here in Minnesota during the next several decades. Therefore, the state, its communities, and individuals also need to assess, plan for, and adapt to risks posed by our changing climate.

Minnesota is warming more quickly than either the U.S. or the global average rate.

The range of Lyme disease is expanding as Minnesota warms:

A warming climate is one factor leading to an increased distribution of ticks in Minnesota and thus greater chance of exposure to tick-borne diseases.



SOURCE: Minnesota Department of Health

**Minnesota's climate is changing:
We need to work to reduce greenhouse gas emissions and adapt to climate impacts.**



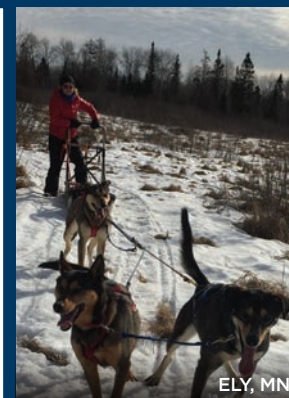
WE HAVE TO ADAPT

The state needs to prepare for the risks of climate change by increasing our resilience so that when extreme events occur, communities and businesses recover more quickly.



INCREASE IN EXTREME WEATHER EVENTS

Minnesota is experiencing an increase in the frequency of extreme events. In particular, mega-rains are damaging infrastructure and causing severe flooding.



LOST HERITAGE

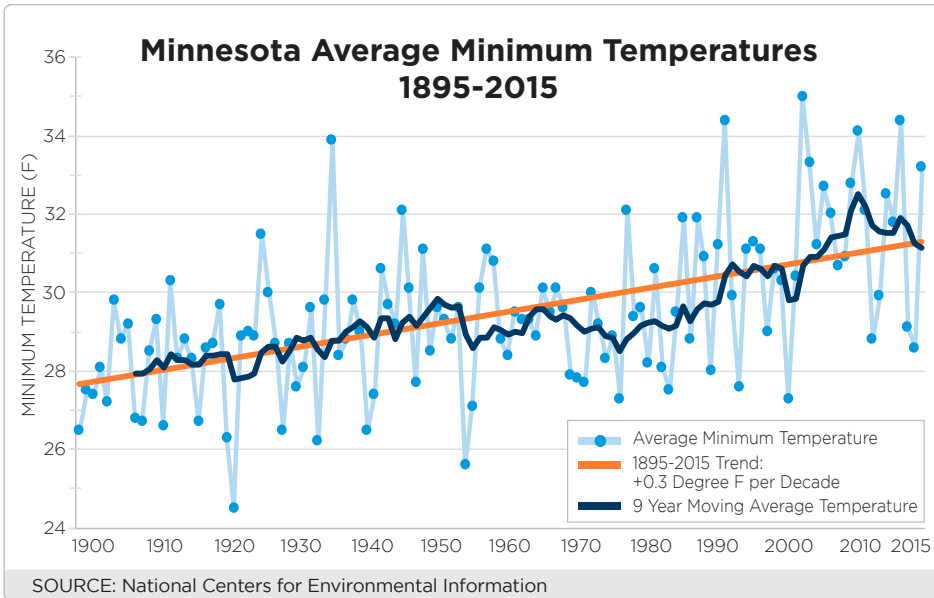
Climate change impacts how we play. Warming winters are reducing the snowmobile, skiing, and ice fishing season by weeks. This, in turn, impacts our cultural heritage and how we share our Minnesota traditions with the next generation.

Temperature



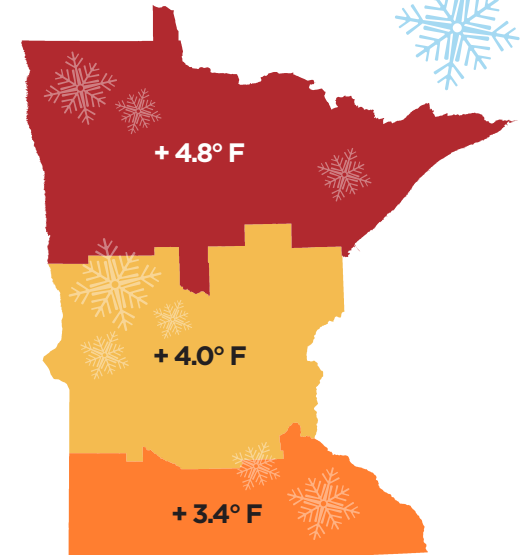
Minnesota's climate is changing rapidly with increasing temperatures, especially in winter and at night, and with increasing frequency of extreme precipitation.

Since 1895, **winter lows** in northern Minnesota have increased 40% faster than in southern Minnesota.



Minnesota is warming faster than both national and global averages, with much of that warming occurring when it's typically the coldest. Nighttime low temperatures in Minnesota have risen by 3° F since 1895, with the most warming taking place during the winter and in the northern parts of the state. Although some Minnesotans might view a warming during winter as a major improvement, the reality is that we have already begun to see detrimental impacts to our natural resources and to popular recreational activities such as ice fishing, skiing, and snowmobiling. Also, the warmer summer nights we've experienced have made it more difficult to keep cool. This is especially problematic in cities where the built environment creates "heat islands" that make it even warmer, and where hot nights disproportionately affect low-income individuals, the elderly, the very young, and those experiencing homelessness.

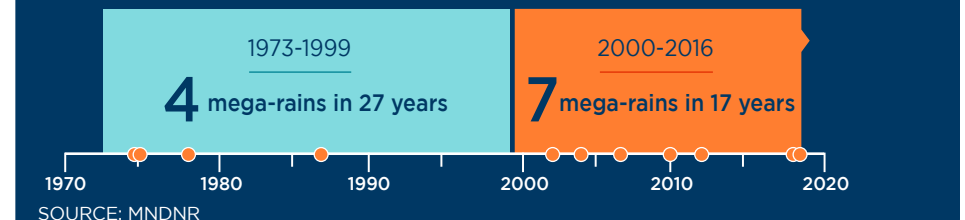
Rising global temperatures have evaporated more water into the air, providing additional fuel for our largest rainstorms. Since 2000, Minnesota has seen seven catastrophic "mega-rain events"—when at least six inches of rain affects an area greater than 1000 square miles. The 27 years from 1973 through 1999 only saw four such storms, and 2016 became the first year on record with more than one. With more warming expected, Minnesota should be prepared for a continued increase in these devastating storms.



SOURCE: MNDNR



Timeline of Minnesota's historic mega-rain events 1973-2016

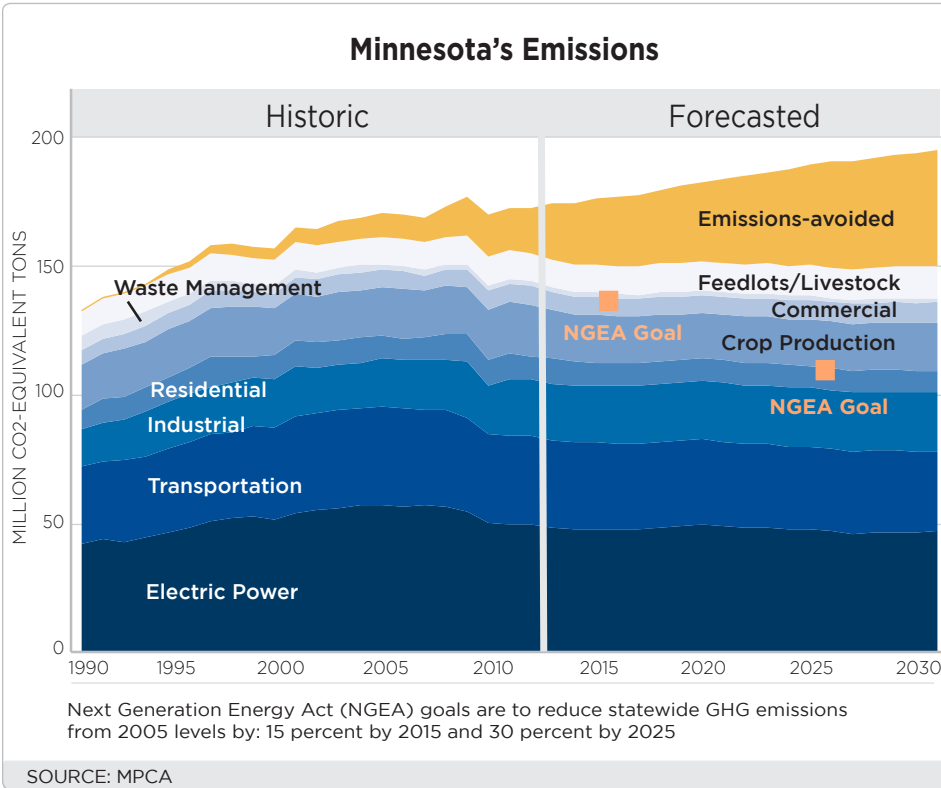


Since 1970, winter as a season has warmed 10 times faster than summer!

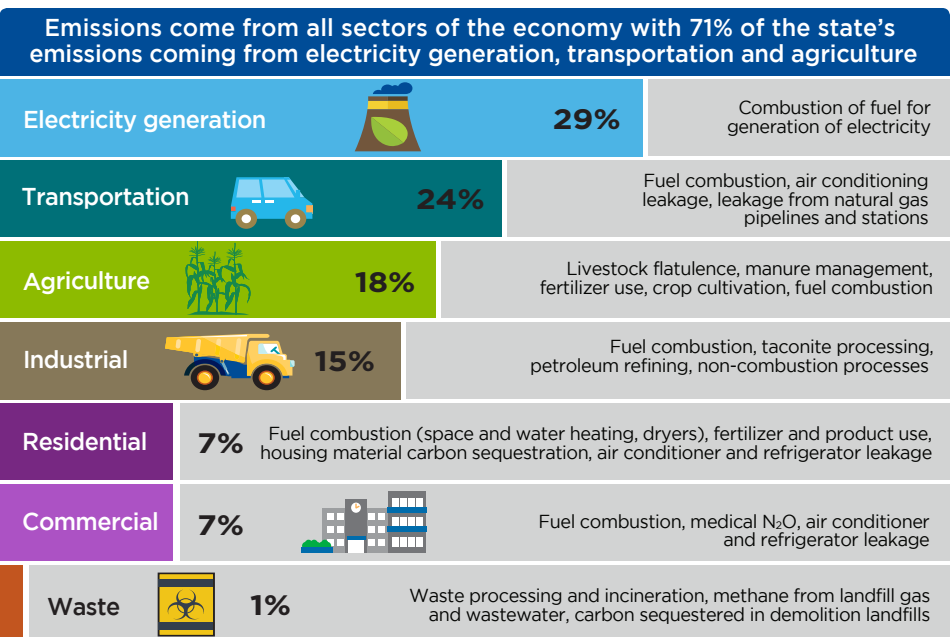
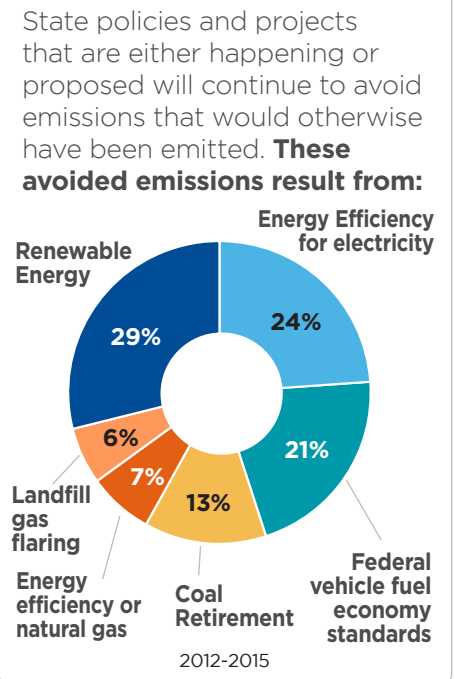
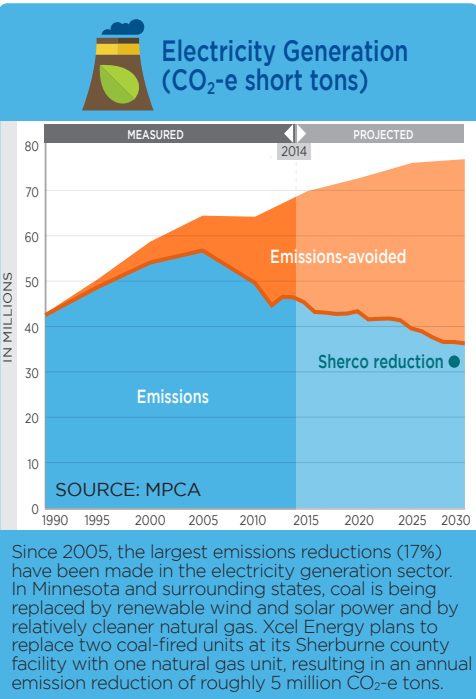
Greenhouse Gas Emissions



Minnesota has strong climate goals, but is not on track to reduce its contributions to climate change.



Greenhouse gasses in the atmosphere trap heat from the sun, leading to warming of the atmosphere and surface of the planet. Human-caused increases in the amount of these gasses in the atmosphere are altering Earth's climate. By tracking the state's emissions, we can identify major sources for potential reductions. We can also project future emissions based on compliance with existing state and federal law, population and economic trends, forecasted technology changes, and proposed energy and industrial projects. Minnesota is committed by state statute to work towards the goal of reducing annual emissions of greenhouse gasses by 80% between 2005 and 2050. While much progress has been made, the 2050 goal will require policies well beyond those already in place at the federal or state level.

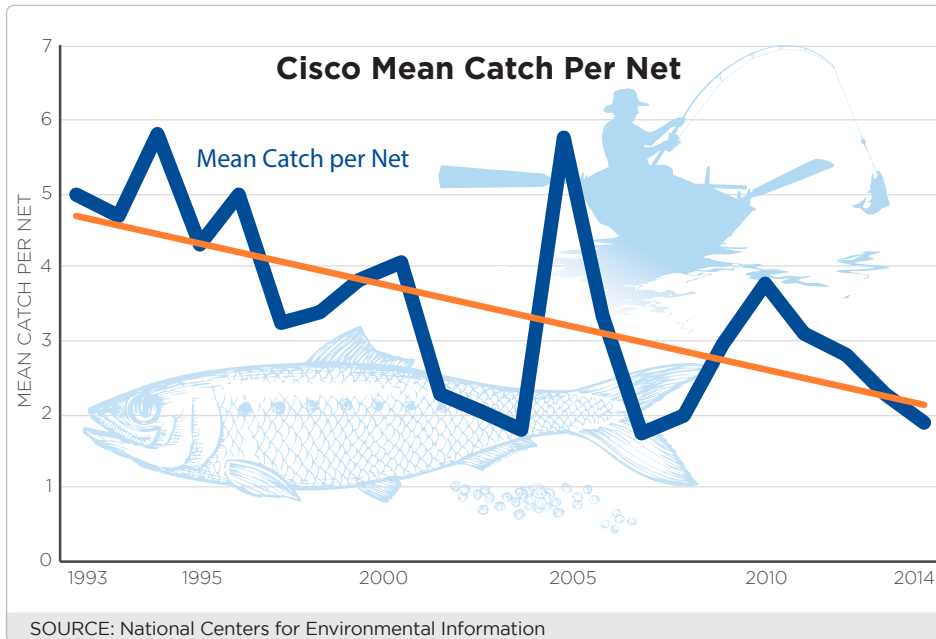


SOURCE: MPCA Greenhouse Gas Emission Inventory

Climate Change and Wildlife



Cisco populations are declining with increasing temperatures, impacting walleye and trout that rely on them as a food source.



Do Your Part

- Participate with local or national conservation groups to support landscape conservation and adaptation.
- Address what you can control – as you landscape your own yard or property be careful to avoid invasive species and try to minimize runoff.

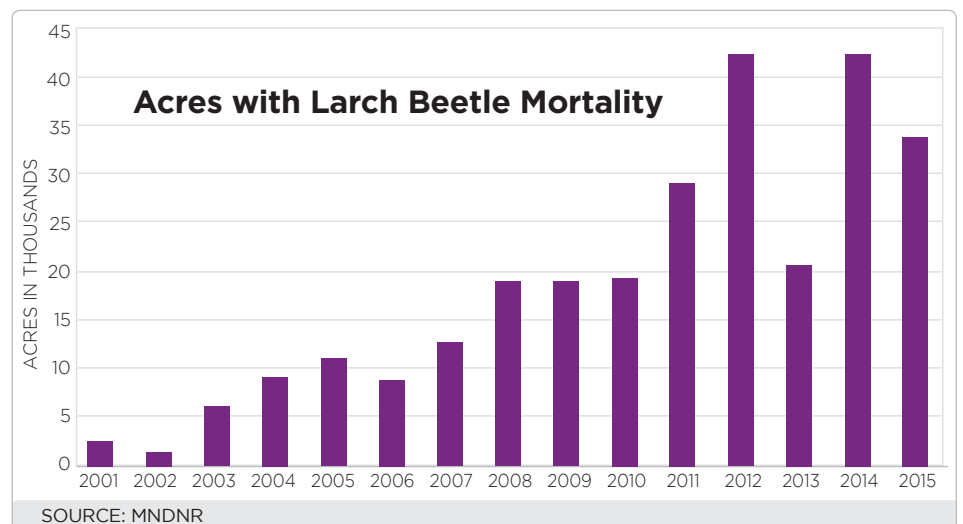
Resource managers and landowners are increasingly managing for climate change. Simply working to keep the same landscape in place is no longer an option.

The eastern larch beetle is taking advantage of longer summers related to climate change to reproduce twice each year rather than just once. The increased beetle population is, in turn, killing larger numbers of tamarack trees. As the forest composition changes, there are further impacts on populations of forest wildlife.



Climate has a strong influence on Minnesota's wildlife and native plant populations. Historical records show that temperature and precipitation patterns in Minnesota are changing. These changes have both direct and indirect impacts on fish, wildlife, and plants. For example, warming lakes directly impact cisco fish, which are sensitive to water temperatures and are experiencing population declines as a result. Cisco are an important food source for larger game fish, such as walleye. Climate-driven declines in cisco population indirectly impact walleye populations by reducing a key food source.

The stress of a changing climate on Minnesota's fish, wildlife and plants is further increased by continued introduction of invasive plants and animals that are not native to Minnesota, fragmentation of large habitat areas into smaller and less connected habitats, conversions of natural areas into developed lands and croplands, and pollution from our cities, roads, and croplands that runs off into our lakes, streams and rivers.



References/More Information:

General

Metropolitan Council. *Thrive MSP 2040: One Vision, One Metropolitan Region*. Retrieved from <https://metro council.org/Planning/Projects/Thrive-2040.aspx>.

Metropolitan Council. (2015). *Local Planning Handbook*. St. Paul, MN: Metropolitan Council.

Water

Clean Water Fund. (2014). *Minnesota's Clean Water Roadmap*. St. Paul, MN: State of Minnesota.

Interagency Coordination Team. (2014). *Clean Water Fund Performance Report*. St. Paul, MN: State of Minnesota.

Metropolitan Council. (2015). *Master Water Supply Plan*. St. Paul, MN: State of Minnesota.

Minnesota Department of Agriculture. *Minnesota Agricultural Water Quality Certification Program*. Retrieved from www.mda.state.mn.us/awqcp.

Minnesota Department of Agriculture. (2015). *Minnesota Nitrogen Fertilizer Management Plan*. St. Paul, MN: State of Minnesota.

Minnesota Department of Agriculture. *Township Testing Program*. Retrieved from www.mda.state.mn.us/townshiptesting.

Minnesota Department of Agriculture. (2016). *Township Testing Program Update*. St. Paul, MN: State of Minnesota.

Minnesota Department of Health. *Minnesota Public Health Data Access - Drinking Water Quality*. Retrieved from <https://apps.health.state.mn.us/mndata/drinkingwater>.

Minnesota Department of Natural Resources. (2013). *Draft Groundwater Strategic Plan*. St. Paul, MN: State of Minnesota.

Minnesota Department of Natural Resources. (2015). *Minnesota Water Use Data*. Retrieved from www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html.

Minnesota Department of Natural Resources. (2016). *Report to the Minnesota State Legislature: Definitions and Thresholds for Negative Impacts to Surface Waters*. St. Paul, MN: State of Minnesota.

Minnesota Pollution Control Agency. (2014). *Minnesota's Clean Water Roadmap*. St. Paul, MN: State of Minnesota.

Minnesota Pollution Control Agency. (2013). *Nitrogen in Minnesota Surface Waters*. St. Paul, MN: State of Minnesota.

Minnesota Pollution Control Agency. (2014). *The Minnesota Nutrient Reduction strategy*. St. Paul, MN: State of Minnesota.

Minnesota Pollution Control Agency. (2014). *Watershed Achievements Report*. St. Paul, MN: State of Minnesota.

Minnesota Pollution Control Agency. (2015). *Swimmable, Fishable, Fixable?* St. Paul, MN: State of Minnesota.

Randall, G.W., D.R. Huggins, M.P. Russelle, D.J. Fuchs, W.W. Nelson, and J.L. Anderson. 1997. Nitrate Losses through Subsurface Tile Drainage in Conservation Reserve Program, Alfalfa, and Row Crop Systems. *Journal of Environmental Quality*. 26:1240-1247.

Sobota, D. J., Compton, J.E., McCrackin, M.L., & Singh, S. (2015). Cost of reactive nitrogen release from human activities to the environment in the United States. *Environ. Res. Lett.* 10(2): 0250006.

Water Resources Center. (2011) *Minnesota Water Sustainability Framework*. St. Paul, MN: Water Resources Center.

Land

Dahl, T.E. (2014). *Status and Trends of Prairie Wetlands in the United States 1997 to 2009*. Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service.

Decision Innovations Solutions. (2013). *2013 Multi-State Land Use Study: Estimated Land Use Changes 2007-2012*. Urbandale, IA: Decision Innovations Solutions.

Doherty, Kevin, Ryba, Adam, Stemler, Casey, Niemuth, Neal & Meeks, William. (2012). *Conservation Planning in an Era of Change: State of the U.S. Prairie Pothole Region*. Washington, D.C.: U.S. Department of the Interior, Wildlife Society Bulletin.

Minnesota Board of Water and Soil Resources. (2016). *Conservation Lands Summary*. Retrieved from www.bwsr.state.mn.us/easements/CLS_Statewide_Summary.pdf.

Minnesota Department of Agriculture. *Farmland Protection*. Retrieved from www.mda.state.mn.us/protecting/farmlandprotection.aspx.

Minnesota Department of Natural Resources. *Natural Resource Planning*. Retrieved from www.dnr.state.mn.us/nrplanning/index.html.

Minnesota Department of Natural Resources. (2015). *Pheasant Summit Action Plan*. St. Paul, MN: State of Minnesota.

Minnesota Geospatial Commons Database. Retrieved from <https://gisdata.mn.gov/>.

Minnesota Geospatial Information Office. *Land Use/Cover Information for Minnesota*. Retrieved from www.mngeo.state.mn.us/chouse/land_use.html.

Minnesota Prairie Plan Working Group. (2011). *Minnesota Prairie Conservation Plan*. Minneapolis, MN: Minnesota Prairie Plan Working Group.

Remote Sensing and Geospatial Analysis Laboratory, University of Minnesota. *Remote Sensing and Geospatial Analysis*. Retrieved from <http://rsl.gis.umn.edu>.

Reynolds, Ronald, Shaffer, Terry, Renner, Randy, Newton, Wesley, & Bett, Bruce. (2001). Impact of the Conservation Reserve Program on Duck Recruitment in the U.S. Prairie Pothole Region. *The Journal of Wildlife Management*. 65(4): 765-780.

Wright, Christopher & Wimberly, Michael. (2012). Recent land use change in the Western Corn Belt threatens grasslands and wetlands. *Geographic Information Science Center for Excellence*. Brookings, SD: South Dakota State University.

Air

Minnesota Department of Health. (2014). *Advancing Health Equity in Minnesota: Report to the Legislature*. St. Paul, MN: State of Minnesota. www.health.state.mn.us/divs/chs/healthequity/ahe_leg_report_020414.pdf

Minnesota Department of Health. *Minnesota Public Health Data Access – Asthma*. Retrieved from <https://apps.health.state.mn.us/mndata/asthma>.

Minnesota Pollution Control Agency & Minnesota Department of Health. (2015). *Life and Breath: How Air Pollution Affects Public Health in the Twin Cities*. St. Paul, MN: State of Minnesota.

Energy

Minnesota Automobile Dealers Association. (2015). *Minnesota Dealer Outlook*. St. Paul, MN: Minnesota Automobile Dealers Association.

Metropolitan Council. (2015). *2040 Transportation Policy Plan*. St. Paul, MN: Metropolitan Council.

Minnesota Pollution Control Agency. *Motor Vehicle Pollution*. Retrieved from www.pca.state.mn.us/air/motor-vehicle-pollution.

S.F. 145, Next Generation Energy Act of 2007. 85th Legislature. (2007).

U.S. Energy Information Administration. *Use of Energy Explained: Energy Use for Transportation*. Retrieved from www.eia.gov/energyexplained/index.cfm?page=us_energy_transportation#tab1.

Climate

Hansen, Gretchen, Read, Jordan, Hansen, Jonathon, & Winslow, Luke. (2016). Projected shifts in fish species dominance in Wisconsin lakes under climate change. *Global Change Biology*. 22(9).

Homeland Security and Emergency Management. *Weather Safety in Other Languages*. Retrieved from <https://dps.mn.gov/divisions/hsem/weather-awareness-preparedness/Pages/weather-safety-other-languages.aspx>.

Jacobson, Peter, Fang, Xing, Stefan, Heinz & Pereira, Donald. (2008). The effects of climate change and eutrophication on cisco *Coregonus artedii* abundance in Minnesota lakes. *Advances in Oceanography and Limnology*. 63: 417-427.

Jacobson, Peter, Fang, Xing, Stefan, Heinz & Pereira, Donald. (2010). Coldwater fish oxythermal habitat in Minnesota lakes: influence of total phosphorus, July air temperature, and relative depth. *Canadian Journal of Fisheries and Aquatic Sciences*. 67: 2001-2013.

Jacobson, Peter, Fang, Xing, Stefan, Heinz & Pereira, Donald. (2011). Protecting cisco (*Coregonus artedii* Lesueur) oxythermal habitat from climate change: building resilience in deep lakes using a landscape approach. *Advances in Oceanography and Limnology*. 64: 323-332.

Minnesota Department of Employment and Economic Development. (2014). *Minnesota Clean Energy Economy Profile: How Industry Sectors are Advancing Economic Growth*. St. Paul, MN: State of Minnesota.

Minnesota Department of Health. (2014). *Minnesota Climate Change Vulnerability Assessment*. St. Paul, MN: State of Minnesota.

Minnesota Department of Health. (2015). *Minnesota Climate and Health Profile report*. St. Paul, MN: State of Minnesota.

Minnesota Department of Health. *Climate and Health*. Retrieved from www.health.state.mn.us/divs/climatechange.

Minnesota Department of Health. *Minnesota Public Health Data Access – Lyme Disease*. Retrieved from <https://apps.health.state.mn.us/mndata/lyme>.

Minnesota Department of Natural Resources. *Historic Mega-Rain Events in Minnesota*. Retrieved from www.dnr.state.mn.us/climate/summaries_and_publications/mega_rain_events.html.

Minnesota Environmental Quality Board. (2014). *Minnesota and Climate Change: Our Tomorrow Starts Today*. St. Paul, MN: State of Minnesota.

Minnesota Environmental Quality Board. (2016). *Climate Solutions and Economic Opportunities: A foundation for Minnesota's state climate action planning*. St. Paul, MN: State of Minnesota.

Minnesota Pollution Control Agency. (2013). *Adapting to Climate Change in Minnesota: 2013 Report of the Interagency Climate Adaption Team*. St. Paul, MN: State of Minnesota.

Minnesota Pollution Control Agency & Minnesota Department of Commerce. (2015). *Greenhouse Gas Emissions Reduction Biennial Report to the Minnesota Legislature*. St. Paul, MN: State of Minnesota.

National Oceanic and Atmospheric Administration. (2014). *NOAA Atlas 14 Point Precipitation Frequency Estimates: Minnesota*.

National Oceanic and Atmospheric Administration. *Climate at a Glance Data*. Retrieved from www.ncdc.noaa.gov/cag/time-series.

O'Brien, Chris. *Refuge for Tullibees: Protecting private forests could help save Minnesota's tullibees, important forage fish for many game fish species*. Retrieved from www.dnr.state.mn.us/mcvmagazine/issues/2016/may-jun/refuge-lakes.html.



Printed on 100% post-consumer waste recycled paper.
The state of Minnesota is an equal opportunity employer and service provider.
Upon request, this document can be made available in alternative formats by calling 651-259-7114.
2017

