ENVIRONMENTAL QUALITY BOARD

PUBLIC REVIEW DRAFT

Preparing for Minnesota Water Plan 2000

To paraphrase a famous state resource on radio: Minnesota, where the rivers are strong, the lakes are good looking and the fishing is above average.

When the average American hears *Minnesota*, chances are the first image that comes to mind is water. Home to the nation's largest river and big clear lakes teeming with fish, Minnesota is the water capitol of the United States. Minnesotans, as well as tens of thousands of travelers who generate the state's $9 billion tourism economy, count on clean, clear water for drinking, cooking and recreation. What should Minnesotans be doing in the upcoming decade to protect this prized resource?

This review draft is a starting point for public discussions that will take place through February 2000 about the condition of Minnesota water resources and how to measure results through goals, objectives and progress indicators. The outcome will be a new *Minnesota Water Plan*, due to the Legislature in September 2000.

Minnesota Water Plan 2000 is a major component of Governor Jesse Ventura's Water Management Unification Initiative. Key elements of this initiative include:

- Focusing on major river basins, such as the Minnesota, Mississippi and Red rivers, to recognize the differences in water resources throughout the state and local water priorities.
- Staying flexible to coordinate efforts with the work of existing local boards, activities and major programs, such as the joint powers boards and the Pollution Control Agency's basin planning.
- Unifying efforts through interagency teams and cooperating with the many groups in each basin.
- Measuring results by selecting water objectives with targets for 2010 and tracking how Minnesota is doing.

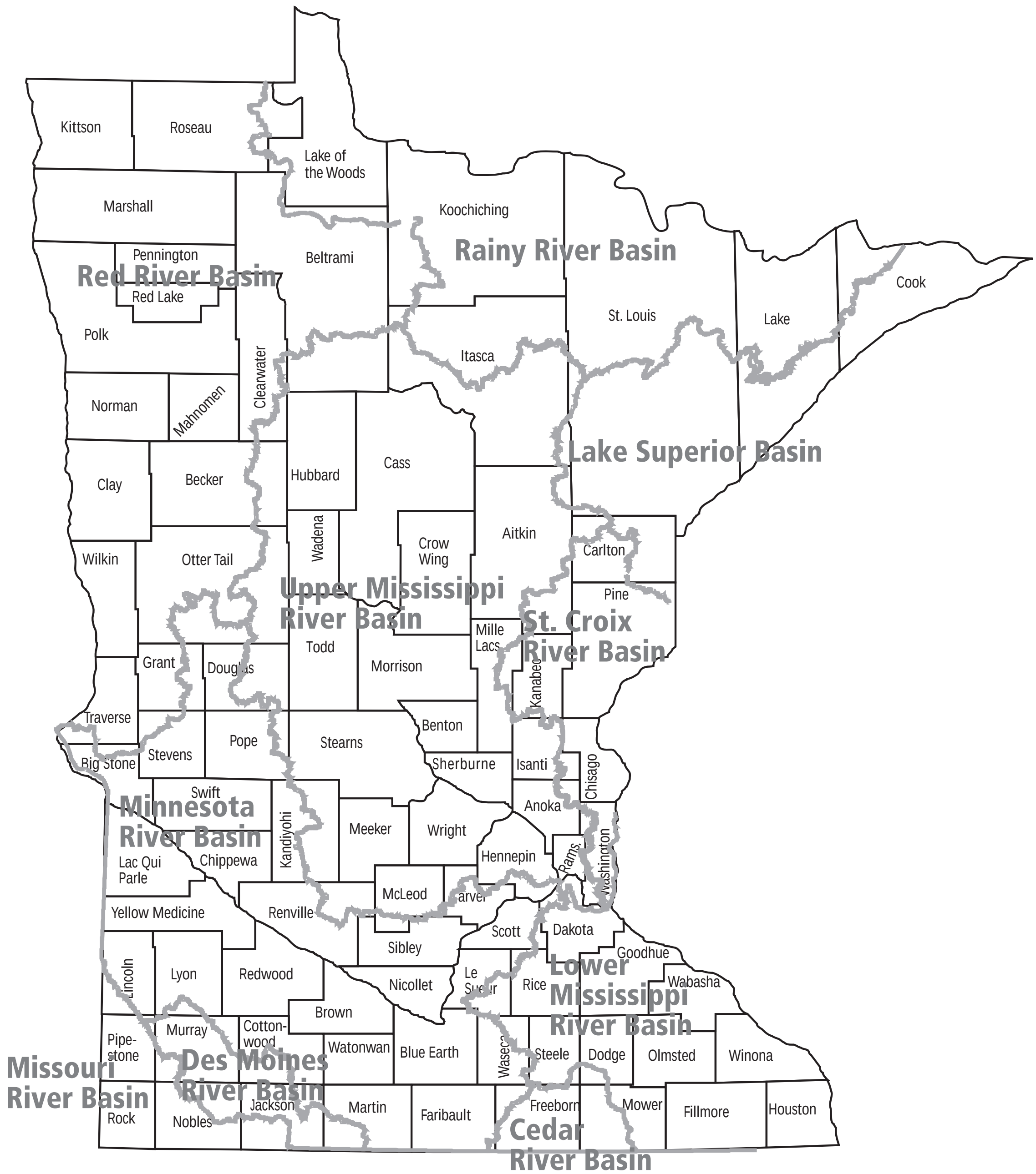
This review draft presents four goals, 10 objectives and 29 indicators. The model for creating these tools was *Minnesota Milestones 1998*, a project that measured progress toward 19 state goals in the 1990s. Refocusing the *Milestones* environmental goals on water, the Environmental Quality Board Water Resources Committee and a Water Management Unification Task Force suggest these objectives and indicators. The draft also provides available trend information to show the condition of water resources in Minnesota; if information is lacking, the indicator is presented as a "snapshot in time." In many basins, local information may be better and can be used to augment the data in this draft.

INSIDE

Minnesota Water Plan 2000 is using river basins for planning efforts

The land in Minnesota drains into 10 major river basins. Water from these basins flows in three directions: the Red and Rainy flow north; the Lake Superior basins flows east; the remaining basins flow south.

To develop the 10-year water plan, interagency basin teams will lead public information efforts. For planning purposes several water basins will be combined. The Minnesota, Des Moines and Missouri river basins in the southwestern part of the state will be discussed as a group. The Lower Mississippi and Cedar river basins in southeastern Minnesota also will be grouped. Even though planning efforts will be combined for these two areas, citizens can develop separate objectives, indicators and targets for their individual river basins.



To help shape the 10-year water plan, check the Minnesota Planning web site at www.mnplan.state.mn.us/eqb/water.html for contacts and meetings in your area.

Trend highlights

Significant reductions have been reported in state streams for serious water pollutants: biochemical oxygen demand, phosphorus, ammonia and fecal coliform bacteria, as measured at sites with historic records. Nitrogen pollution levels are increasing, and suspended solids remain a problem.

Monitoring shows pollutants seeping into ground water throughout the state. Nitrate levels are high in many places and volatile organic compounds were found across the state. Atrazine, a common pesticide, is declining in wells monitored over time in central Minnesota but remaining about the same in southeast Minnesota.

Water levels are constantly changing in lakes, streams and ground water due to natural conditions and pressures of human activity, and vary considerably across the state. Stream flow reflects periodic drought and flood conditions. Water use for many purposes increases when the water levels are in drought condition.

Water resources are a key factor in ecosystem health. Information about trends in key species, such as frogs and aquatic invertebrates, is lacking. Mallard and bald eagle populations are increasing. Threats from the introduction of exotic species, such as eurasian watermilfoil, are increasing.

The public has more opportunities to use lakes and streams with the growth in public access sites and fishing piers. Boater satisfaction is high in surveys, but concern about crowding has risen. Fishing pressures vary from lake to lake. Fishing on walleye lakes has increased steadily since the 1950s, along with the time needed to catch a fish.

What are the next steps? Teams in each of the river basins are leading efforts using this draft to shape the state's 10-year water plan. Public input will be gathered from local governments, water interests and citizens. Reviewers are encouraged to consider the big picture when reviewing this draft and making suggestions. Questions to ask in reviewing this draft include:

- Do the draft goals and objectives address water needs? If not, what would?
- Will each indicator track progress in meeting the objective? If not, what measurement should be used?
- In addition, what indicators of human behaviors or actions that pose a risk to the water resources should be tracked to prevent or correct water problems?
- For each indicator, what should the target be for 2010?

This draft report will be the focus of discussions that will take place across the state in the upcoming months. Minnesotans who care about the state's lakes, streams and drinking water should use this opportunity to shape *Minnesota Water Plan 2000*. For updates or to provide comments electronically, visit the Minnesota Planning web site at: www.mnplan.state.mn.us/eqb/water.html.

Goals, objectives and indicators at a glance

Goal: Minnesotans will improve the quality of water resources

Objective A: Protect and improve water quality in streams

Measure levels of pollutants in streams:

Indicator 1: Phosphorus

Indicator 2: Nitrogen

Indicator 3: Ammonia

Indicator 4: Biochemical oxygen demand

Indicator 5: Total suspended solids

Indicator 6: Fecal coliform bacteria

Objective B: Protect and improve lake water quality

Indicator 7: Secchi transparency in lakes

Objective C: Prevent degradation of ground-water quality and reduce concentrations of contaminants
Measure levels of pollutants in ground water:

Indicator 8: Nitrate

Indicator 9: Chloride

Indicator 10: Volatile organic compounds

Indicator 11: Total atrazine

Indicator 12: Fecal coliform bacteria

Goal: Minnesotans will conserve water supplies and maintain the diverse characteristics of water resources to give future generations a healthy environment and a strong economy

Objective D: Maintain ground-water levels to sustain surface water bodies and provide water supplies for human development

Indicator 13: Water levels in wells

Objective E: Maintain flow of rivers and streams within historical range of variation

Indicator 14: Trends in stream flow

Objective F: Maintain the quality and diversity of Minnesota's lakes and wetlands while acknowledging regional variation

Indicator 15: Changes in wetland acres

Goal: Minnesotans will restore and maintain healthy ecosystems that support diverse plants and wildlife

Objective G: Ensure that aquatic environments have conditions suitable for the maintenance of healthy self-sustaining communities of plants and animals

Indicator 16: Blue-winged teal population

Indicator 17: Mallard population

Indicator 18: Percent of lakes where loons reproduce successfully

Indicator 19: Number of territories occupied by bald eagles

Indicator 20: Frog and toad populations

Indicator 21: Aquatic invertebrates population

Indicator 22: Walleye population

Objective H: Limit introduction and spread of exotic species

Indicator 23: Number of water bodies with Eurasian watermilfoil

Indicator 24: Miles of waterways and number of lakes and reservoirs with zebra mussels

Goal: Minnesotans will have reasonable and diverse opportunities to enjoy the state's water resources

Objective I: Provide appropriate access to water recreation sites

Indicator 25: Number of sites for boat launching

Indicator 26: Number of public fishing piers

Indicator 27: Miles of stream easements

Objective J: Improve or maintain the quality of water recreation

Indicator 28: Boater satisfaction by surveys

Indicator 29: Angler satisfaction by surveys

Goal: Minnesotans will improve the quality of water resources

As the only state whose waters flow to three major North American drainage basins, Minnesota has a unique responsibility to protect water quality. However, clean and clear water resources are too easily taken for granted. Changing land uses, increased industrial activity and the ever-expanding population create the need for constant vigilance in protecting the state's waters. Pollutants are threatening lakes, streams and ground water. While all water resources are interrelated, the following objectives give streams, lakes and ground water special consideration.

Objective A. Protect and improve water quality in streams

Threats to water quality in streams come from a variety of sources. Nutrients, solids, bacteria and other common pollutants can negatively influence the health of humans and animals and can cause aesthetic problems, inhibiting the use and enjoyment of streams and rivers for recreational purposes. In this objective, six indicators help assess the condition of Minnesota streams.

These indicators are measured by various governmental units such as the Minnesota Pollution Control Agency, the U.S. Geological Survey, the Metropolitan Council, watershed districts, counties, and soil and water conservation districts, as well as by schools and citizens through programs like River Watch. However, only long-term data from the Minnesota Pollution Control Agency has been used in this analysis.

Indicator 1. Phosphorus in streams

Phosphorus is the nutrient directly responsible for causing algae to grow in surface water. While a combination of nutrients are needed for algae to grow, excess phosphorus leads to blooms of algae, some of which can produce gases that are toxic to animals. Algae blooms prevent swimming and other enjoyment of Minnesota waters.

Some sources of phosphorus include fertilizer applied to lawns and crops, animal waste, wastewater treatment plants, dust and soils that are washed into waterbodies, and plant matter like leaves and grass.

The Pollution Control Agency measures total phosphorus, or all of the forms of phosphorus present in the water. Though only certain types of phosphorus cause algae growth, the measure of total phosphorus is a good indicator of the impact of phosphorus on surface water.

Indicator 2. Nitrogen in streams

Nitrogen is another nutrient that can harm water resources. The Minnesota Department of Health has established a drinking water standard of 10 parts per million nitrate-nitrogen based on the risk of methemoglobenemia (blue-baby syndrome) in infants. High levels of nitrogen in the Gulf of Mexico are killing fish, plants and other organisms and causing a large “dead zone” off the Mississippi Delta. The destruction is greatly hurting the seafood industry in the area.

Some sources of nitrogen include fertilizer applied to lawns and crops, animal waste, wastewater treatment plants, dust and soils that are washed into waterbodies, plant matter like leaves and grass and deposition of nitrogen from the atmosphere. The Pollution Control Agency measures nitrate plus nitrite nitrogen as an indicator of nitrogen amounts in streams.

Indicator 3. Ammonia in streams

Ammonia is a compound of nitrogen that in some forms can be toxic to fish and other aquatic life. Chemical changes in ammonia can use up oxygen in the water and can kill fish.

Nitrate and ammonia are forms of nitrogen related through a complex cycle. For example, nitrate is the most common form of nitrogen in oxygenated ground water and surface water; however, when little or no oxygen is present, the ammonium ion can remain stable and nitrate can be reduced to nitrogen gasses.

Some sources of ammonia include fertilizers, animal waste, wastewater and the breakdown of organic matter. The Pollution Control Agency measures un-ionized ammonia. Changes in its concentration can result from changes in pollutant amounts, bacterial breakdown of organic matter and oxidation of ammonia and are affected by the type and location of pollutant source, temperature, season and other factors.

Indicator 4. Biochemical oxygen demand in streams

Biochemical oxygen demand measures the oxygen that is used by microscopic organisms such as bacteria when organic matter decomposes. This can cause unpleasant odors from the bacteria and kill fish by depleting oxygen.

Some sources of biochemical oxygen demand include animal waste, wastewater and other biodegradable material like grass and leaves. The Pollution Control Agency measures biochemical oxygen demand to get an indication of its impact on oxygen supplies in surface waters.

Indicator 5. Total suspended solids in streams

Suspended solids are particles of things like dirt, plants and animals that cause water to be cloudy or less transparent. Solids decrease the amount of light available for aquatic plants and make it difficult for fish, clams and other aquatic animals to breathe and feed. Pesticides, nutrients, metals and bacteria can attach to the solids and bring contaminants into the water.

Some sources of solids include erosion from construction sites and agricultural fields, streambank erosion and other uncovered soil.

Indicator 6. Fecal coliform bacteria in streams

Biological organisms that cause waterborne diseases are among the oldest health threats to drinking-water quality. Waterborne diseases can be caused by a number of different bacteria, viruses and protozoa. These disease-causing organisms live in the intestines of warm-blooded animals and can be spread to water by contact with animal feces. Potential sources of contamination include sewers, septic systems, feedlots and manure spreading.

Symptoms of waterborne diseases include gastrointestinal illnesses such as severe diarrhea, nausea and possibly jaundice, with associated headache and fatigue. These symptoms also result from other factors or diseases. Generally, young children and the elderly are more susceptible to waterborne disease.

The Pollution Control Agency measures fecal coliform to determine the presence of and the potential for disease-causing organisms. The measurement of fecal coliform is affected by sunlight, nutrient levels, temperature, stream flow and other factors. Public water supply systems routinely test for total coliform, fecal coliform, and escherichia coliform (E. coli). While fecal coliform bacteria are not harmful to humans, they indicate contamination from sewage and do suggest the possible presence of disease-causing organisms.

Objective B. Protect and improve lake water quality

Generally, the clearer the water of a lake, the more suitable it is for recreation. The more a lake is polluted by nutrients like phosphorus or solids such as soil from erosion, the more algae will grow in the lake and the dirtier the water will be. High levels of algae or solids decrease transparency; however, some natural materials such as tannic acid from bogs and calcium carbonates discolor water and can reduce transparency as well.

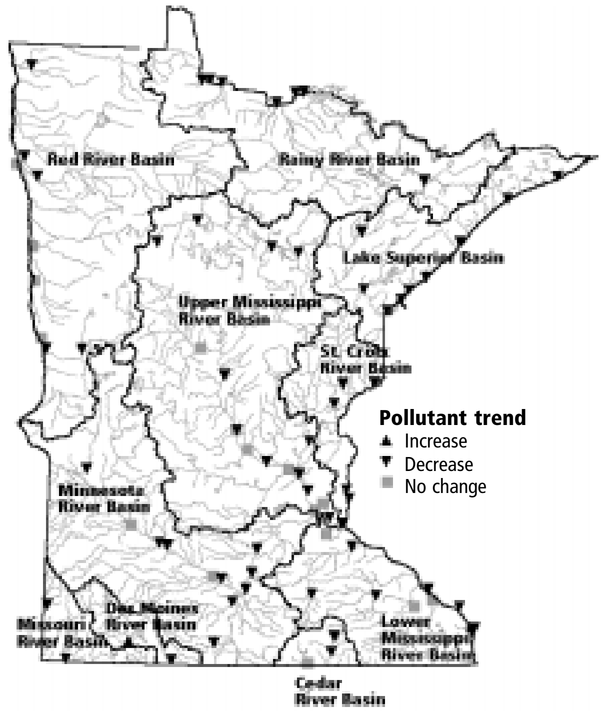
Indicator 7. Secchi transparency in lakes

The expected clarity of lakes varies from place to place in Minnesota due to natural features and characteristics of the landscape and changes in land use and cover.

Some solids and nutrients in lakes come from runoff from farm fields and lawns, lakeshore erosion, failing septic systems, wastewater treatment plants, feedlots, and natural sources like leaves.

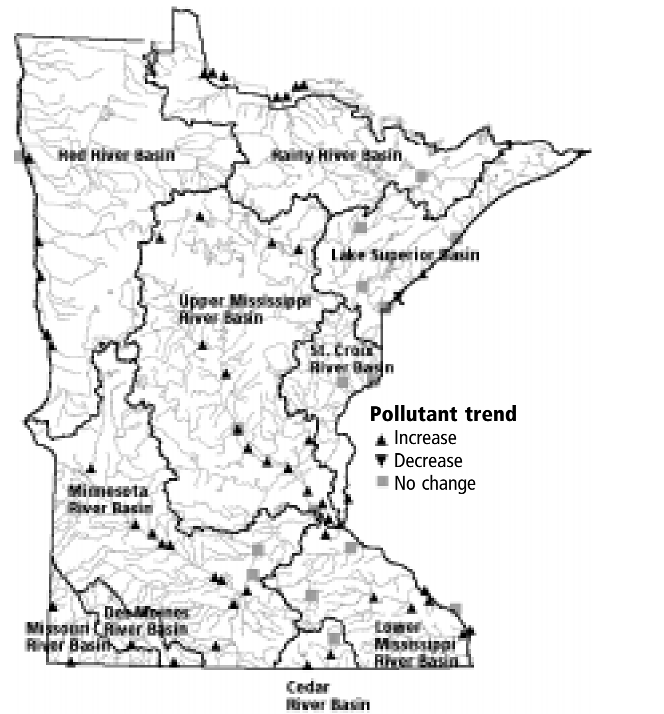
Water clarity is measured using a method called Secchi transparency. This method involves dipping a disk into the water and gauging how deep the disk can be seen. Secchi disk readings are taken all over the state by volunteers and reported to the Pollution Control Agency, providing an indirect measure of algae amounts. Detecting trends requires taking a minimum of four readings each summer for eight to 10 years. The summer mean-transparency of a lake can vary annually in response to changes in amounts of algae, watershed runoff, precipitation and other factors.

Total phosphorus pollutant levels have decreased at nearly eight out of 10 monitoring sites



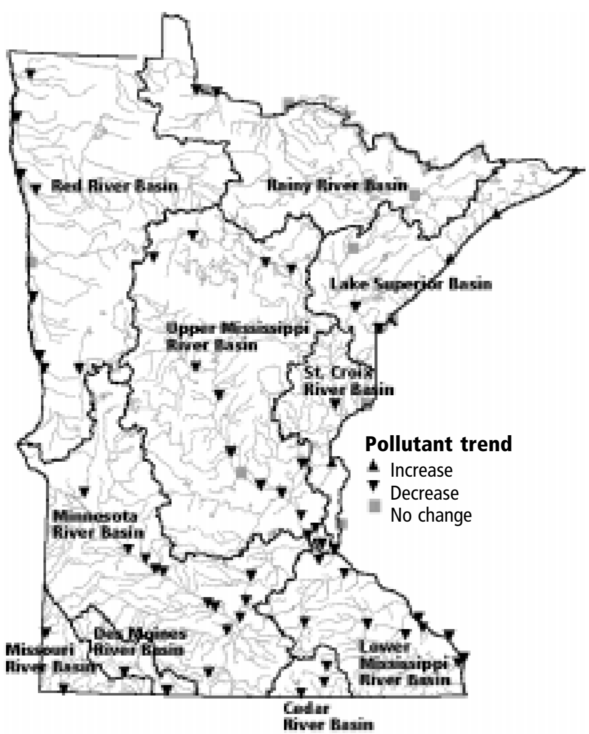
Of the monitoring stations with valid data, 78 percent show a decrease in pollutant levels, 1 percent show an increase, and 21 percent show no particular trend in either direction. Common sources of phosphorous include fertilizer, animal waste, wastewater treatment facilities, and plant matter like leaves.

The health of Minnesota's waterbodies have been negatively effected by increases in the levels of nitrogen



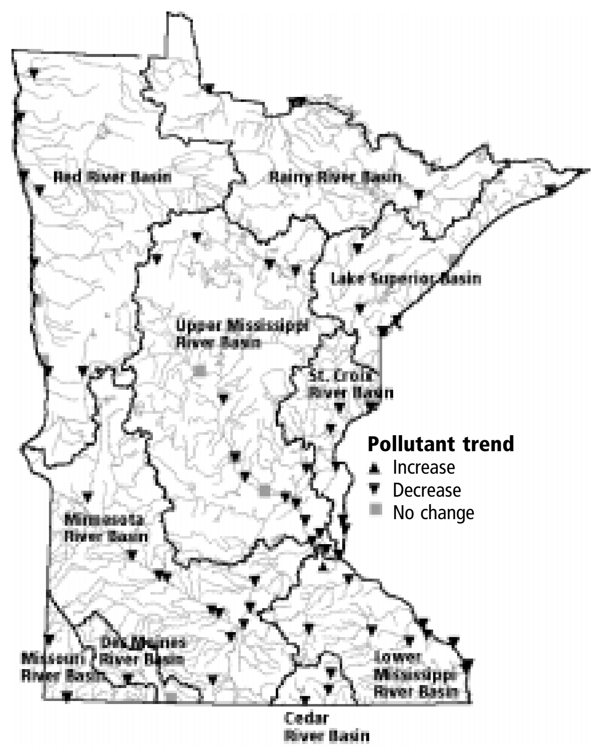
Where valid data exists, 1 percent of monitoring stations show a decrease in pollutant levels, 75 percent show an increase, and 23 percent show no particular trend in either direction. Common sources of nitrogen are plant matter like grass, wastewater treatment plants and fertilizer. Nitrogen is measured as nitrite/nitrate.

Ammonia levels have decreased at nearly all Minnesota monitoring stations



Of the monitoring sites having sufficient data, 83 percent show a decrease in pollutant levels, 4 percent show an increase, and 13 percent show no particular trend in either direction. Animal waste, fertilizer, remnants of organic matter and wastewater are some of the sources of ammonia.

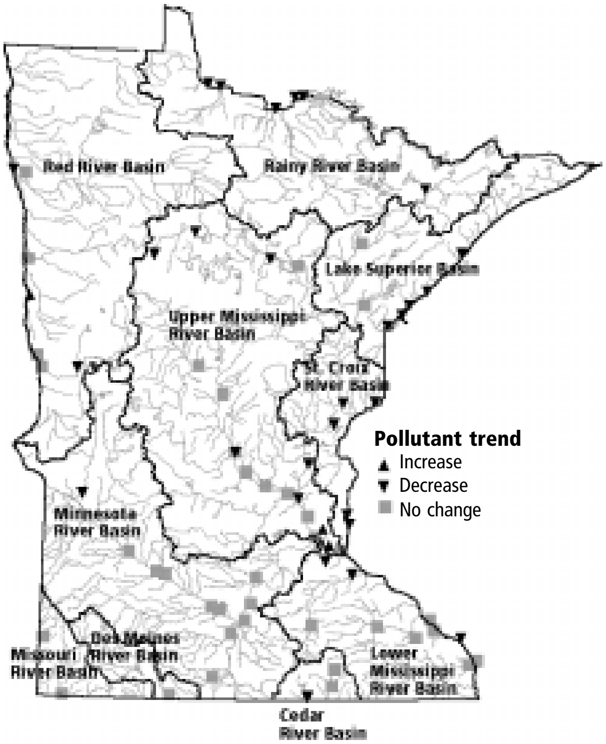
Biochemical oxygen demand levels have decreased at nearly all monitoring sites



Common sources of biochemical oxygen demand include animal waste, wastewater and other biodegradable material. Where valid data exists, 89 percent of the monitoring sites show a decrease in pollutant levels, 1 percent show an increase, and 10 percent show no particular trend in either direction.

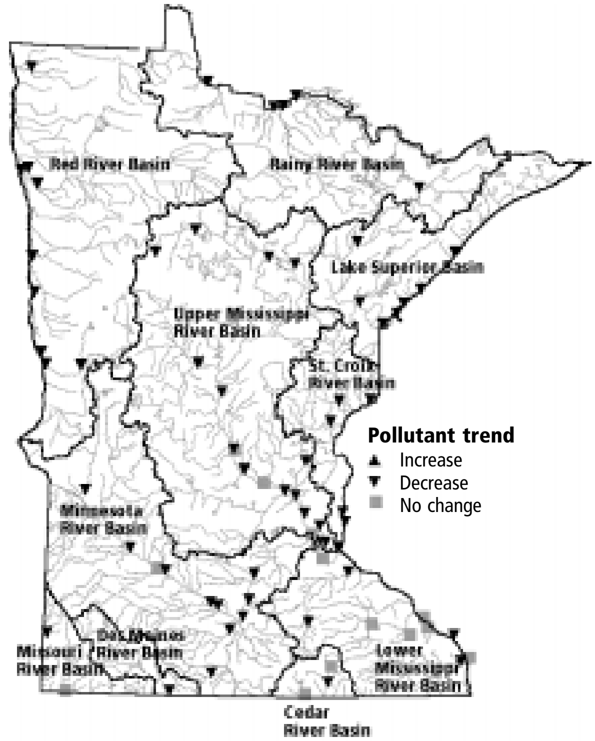
Source: Pollution Control Agency

Over 90 percent of the levels of total suspended solids have either remained constant or decreased



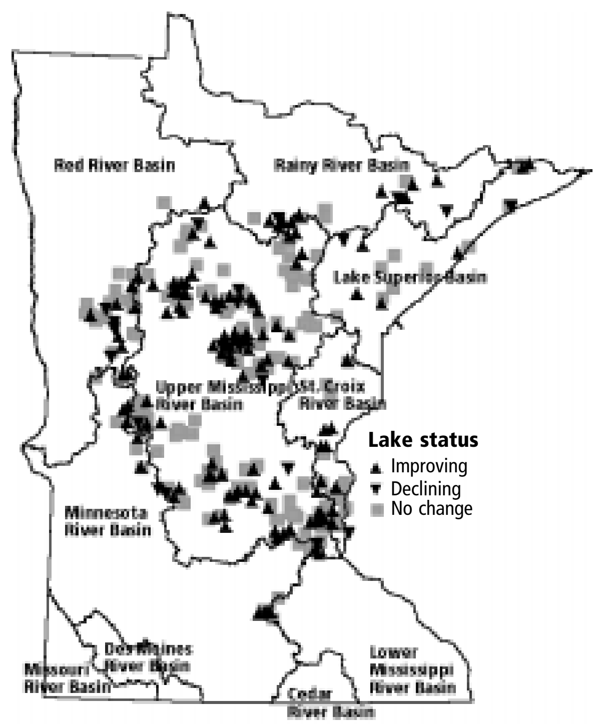
Of the total monitoring sites that have valid data, 41 percent show a decrease in pollutant levels, 4 percent show an increase, and 54 percent show no particular trend in either direction. The most consistent decreases are in the Rainy and the St. Croix river basins. Sources of total suspended solids include erosion from construction sites, agricultural fields as well as any uncovered soil and streambank erosion.

Decreases in fecal coliform bacteria have been experienced throughout Minnesota



All of Minnesota's river basins have experienced decreases in the levels of fecal coliform bacteria. Of the monitoring sites that have valid data on fecal coliform, 82 percent show a decrease in pollutant levels, 0 percent show an increase, and 18 percent show no particular trend in either direction. Fecal coliform sources include human and animal waste.

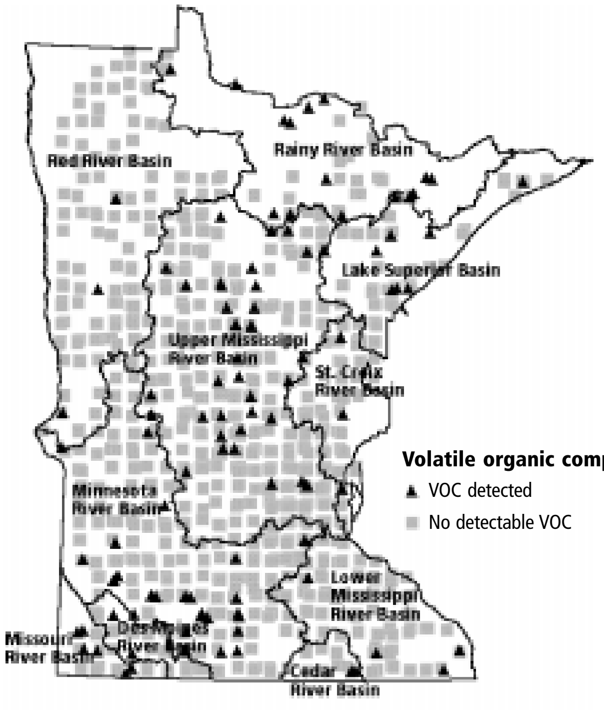
Over 90 percent of monitored lakes have increasing or steady water quality



Of lakes having sufficient data to validly assess trends, 37 percent show an increase in transparency, 8 percent show a decrease and 54 percent show no particular trend in either direction. Clear lakes equate to improved water quality.

Source: Pollution Control Agency

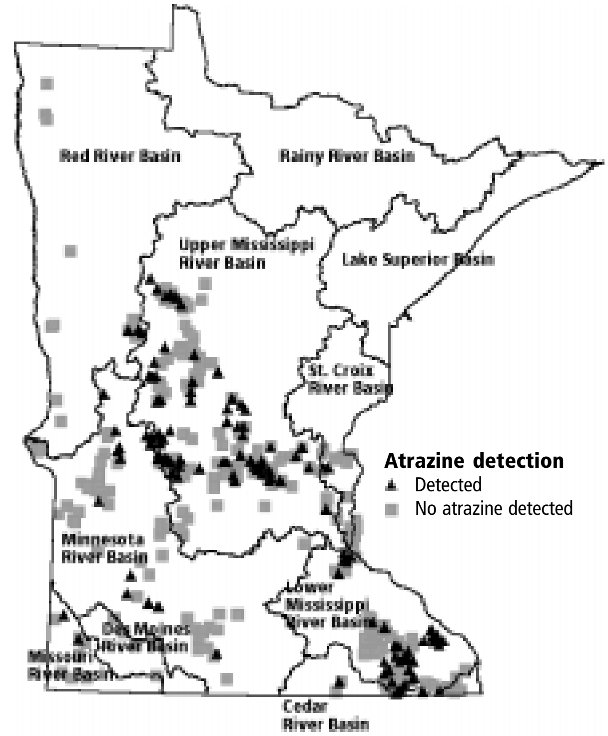
The majority of wells sampled between 1992 and 1996 had no detectable level of volatile organic compounds



Many, but not all of the volatile organic compound detections are in areas where sand and gravel are at the land surface. Nearly one in eight wells sampled had VOC detected.

Source: Pollution Control Agency and Minnesota Geologic Survey

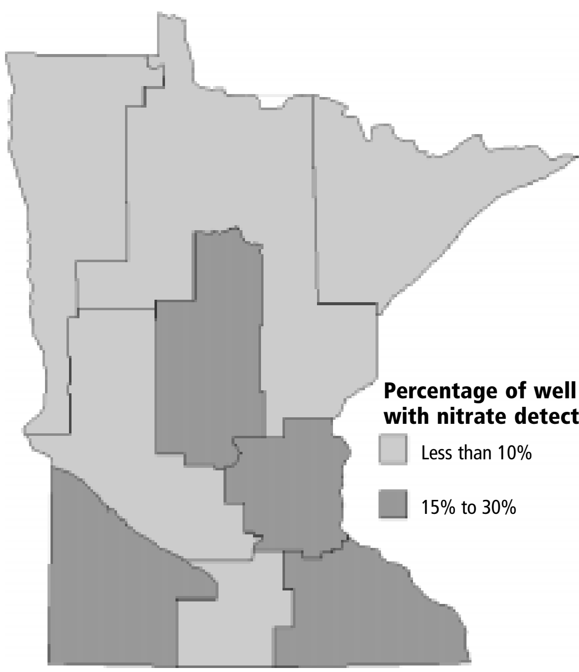
Atrazine is the most commonly detected pesticide in Minnesota



Since 1985, atrazine concentrations in the sand plain in the Upper Mississippi Basin have been declining, but remains steady in the Lower Mississippi Basin.

Source: Department of Agriculture

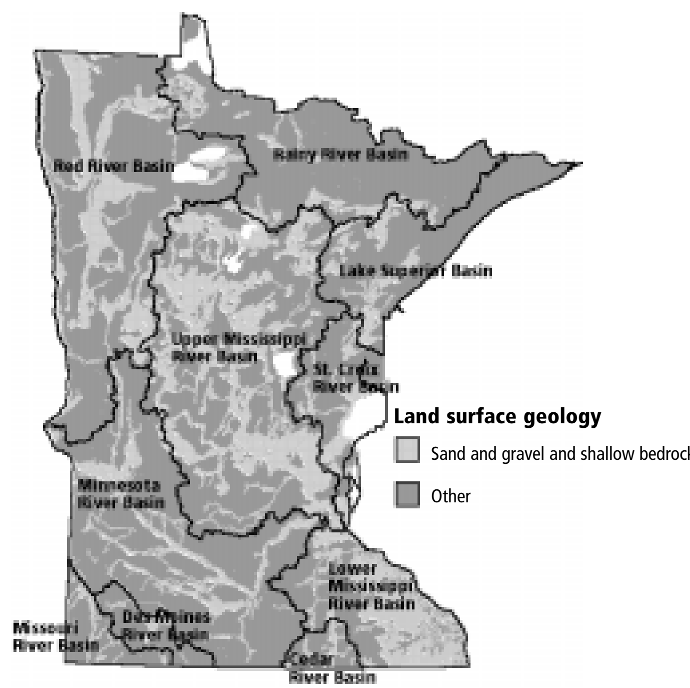
Nitrate contamination poses a greater problem in central and southern areas



Nitrate levels are detected if they exceed one part per million; wells were sampled over a five-year period, 1992 to 1996. Most experts consider nitrate above this level a sign of human influence on water quality. An interagency committee defined the map areas to reflect similar geology and threats to ground water.

Source: Pollution Control Agency

In many places land and ground water are directly connected



When sand, gravel or shallow bedrock conditions occur at the land surface, water moves rapidly into ground water. Pesticides, nitrate and other pollutants can more easily infiltrate into aquifers in these areas than in less porous areas where aquifers are more protected.

Source: Minnesota Geologic Survey

Objective C. Prevent degradation of ground-water quality and reduce concentrations of contaminants

Ground water is a vital source of drinking water for more than 70 percent of Minnesotans and 98 percent of the state's nearly 1,000 community water systems. Identifying trends in ground-water quality is difficult due to the typically long response times of aquifers to changes in activities at the land surface. There is presently no single data set that identifies trends in ground-water quality.

Indicator 8. Nitrate in ground water

Nitrate is the most common contaminant found in ground water in Minnesota and is used nationally as an indicator of overall quality. Nitrate in ground water comes from people and some comes from nature. Nitrate is not a principal component of surface water or ground water unless the water has been affected by human activities. To prevent degradation of ground-water quality, it is necessary to understand how water moves in the subsurface. Nitrate is a good tracer of ground-water movement since elevated nitrate levels in ground water can be used to identify where aquifers have been influenced by activities at the land surface.

The Pollution Control Agency conducted a statewide baseline assessment of ground-water quality in Minnesota by sampling approximately 1,000 private wells between 1992 and 1996. The agency is redesigning its Ground Water Monitoring and Assessment Program to monitor trends in areas of the state where water quality is affected by activities at the land surface. Other data sources include Minnesota departments of Health, Agriculture and Natural Resources, and regional, federal and local sources.

Indicator 9. Chloride in ground water

Chloride, like nitrate, can be introduced into ground water by activities at the land surface. Sources of chloride include community and individual sewage treatment systems and road salt. In addition, chloride can be used to identify the influx of deeper or more naturally saline waters into freshwater aquifers due to excessive pumping. Unlike nitrate, chloride is chemically stable in conditions typical of deeper aquifer settings. In this way it can identify impact of land use on ground-water quality in areas where nitrate no longer exists. The presence of elevated chloride and nitrate in ground water does not necessarily mean that there are other, potentially harmful chemicals in the ground water; rather, by analogy, where there is smoke, there may be fire.

Natural levels of chloride in ground water are higher in some state areas than others. Data from the Pollution Control Agency, Department of Natural Resources and U.S. Geological Survey helps distinguish natural levels of chloride from those introduced by land surface activities.

Indicator 10. Volatile organic compounds in ground water

Volatile organic compounds are chemicals that evaporate rapidly from water into air at normal air temperatures. These chemicals are contained in a wide variety of commercial, industrial and household products, such as fuel oils, gasoline, solvents, cleaners and degreasers, paints, inks, dyes, refrigerants and pesticides. Most volatile organic compounds found in the environment result from human activity.

Volatile organic compounds vary considerably in their harmful effects. The Minnesota Department of Health has developed drinking water standards for many of these compounds. Some of these compounds are known or suspected to cause cancer; others can be harmful to the central nervous system, the kidneys, or the liver; or cause irritation to the skin or mucous membranes.

The Minnesota Department of Health requires public water suppliers to test for volatile organic compounds based on the type of water supply system and on previous analytical results. This information is collected and is available in department databases.

Indicator 11. Total atrazine (atrazine plus metabolites) in ground water

Pesticides vary widely in their effects. Each behaves uniquely as it moves in the water, soil and air, and the rate it breaks down into other compounds; therefore, no one pesticide is a good indicator of the concentration of pesticides in ground water and potential risks to the environment or human health.

Atrazine is suggested as an indicator because it is the only pesticide in Minnesota currently in *common detection status,* which means it is a serious concern for Minnesotans. An advisory committee has determined that detection of atrazine is not due to misuse or unusual or unique circumstances.

The Minnesota Department of Agriculture has sampled more than 425 wells since 1985, representing 13 aquifers. Monitoring efforts have focused on the sandy soils in central Minnesota and the karst bedrock in the southeast part of the state. In these places, ground water is considered susceptible to contamination. Normally, 70 percent or more of samples collected contain no detectable pesticide. Five pesticides — alachlor, atrazine, cyanazine, metolaclor and metribuzin — represent over 95 percent of detections from ground-water monitoring.

Atrazine is detected most commonly, and typically represents more than 90 percent of the detections in any given year. Detections commonly fall between 0.1 and 0.5 parts per billion, with less than 5 percent reported above 1.0 parts per billion. Generally, average atrazine concentrations in the sand plain have been declining in wells monitored over time. In karst areas, atrazine concentrations are remaining about the same.

Indicator 12. Fecal coliform bacteria in ground water

These bacteria are not harmful to humans; however, their presence suggests disease-causing organisms such as E. Coli, salmonella and cryptosporidium. Sources of fecal coliform include human and other animal waste.

If total coliform and fecal coliform or E. coli are detected in ground water, there is strong evidence that fresh sewage is present. As of 1999, all community water suppliers are required to publish an annual consumer confidence report on the quality of their drinking water. In addition to information collected by public water suppliers, the Minnesota Department of Health requires that new wells be tested for total coliform before the well can be used as a source of drinking water.

Goal: Minnesotans will conserve water supplies and maintain the diverse characteristics of water resources to give future generations a healthy environment and a strong economy

Minnesotans take water for granted in planning for development; they expect to find it available everywhere in a quantity and quality that meets their demands. However, supply in some areas is inadequate and elsewhere, contamination has harmed the supply or the natural quality prevents the use of water. Competing users can strain local water supplies. Individual demands for water either stay the same or increase with the decrease in supply during droughts. High water levels that may happen only once a decade need to be considered when planning construction so floods do not cause unnecessary and costly damage.

Objective D. Maintain ground-water levels to sustain surface water bodies and provide water supplies for human development

Minnesota is increasingly tapping into ground water. The use of ground water for public water supplies surpassed surface water in about 1980 and continues to grow. Irrigation, drawing mainly on ground water, doubled between 1986 and 1996. Using too much water from a vulnerable supply could cause lakes, rivers or wells to dry up.

Indicator 13. Water levels in wells

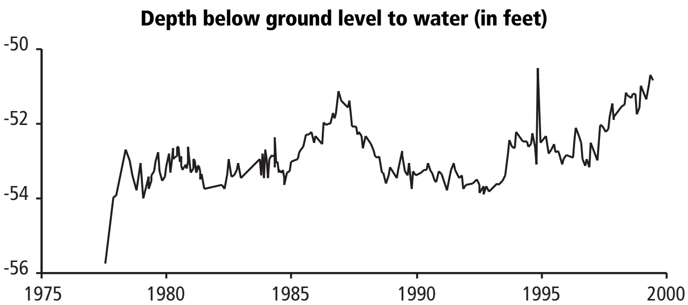
Water-level measurements are a good indicator of overall condition of the water supply. In wells these measurements integrate the effects of climate and other natural variations with the pressures of human activity. People use up large amounts of water and change the land surface so that water runs off rather than drains into the ground. Large variations also occur naturally and may mask the influence of human activity on a regional or basin scale. Minnesotans' demand for water does not take into account the changing amounts of water available. In fact pumping and demand for water tend to increase when rainfall is short and water levels are declining.

The Department of Natural Resources Observation Well network is a collection of about 700 wells that are maintained expressly to measure water levels; they are distributed throughout developed parts of the state in 77 counties. Wells are planned for every state aquifer when network development is complete.

DROUGHT OR LARGE AMOUNTS OF RAIN OR SNOW CHANGE GROUND WATER LEVELS

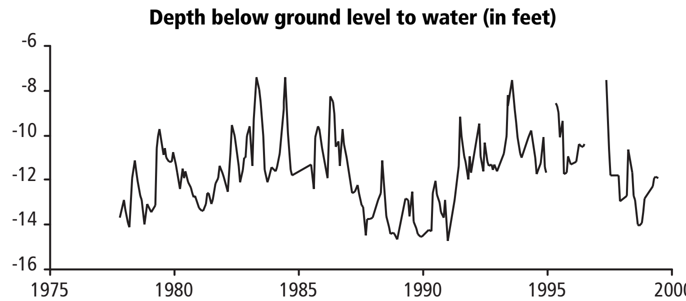
Fluctuations in water levels are primarily due to changing climate conditions; several reflect the droughts of the mid-1970s and mid-1980s. The well hydrographs illustrate the variation expected in the water table within the area it is located. These five wells were selected from among the state's 350 observation wells because they have been measured for a long time and are somewhat centrally located within each basin.

The Red River Basin well varied about 6 feet since the late 1970s.



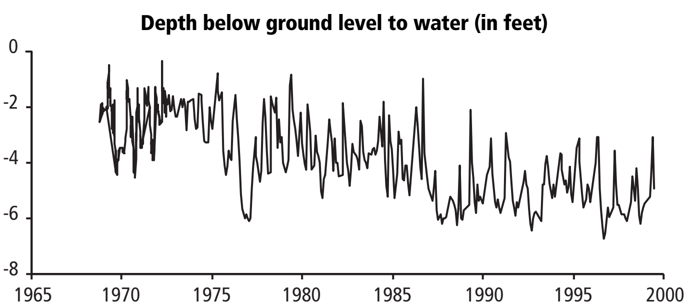
Note: The well measured in this graph is Obwell 3113,T138 R42 S26 CDA in Becker County.

Rain and snowfall contribute to the 7- and 8-foot changes in water levels in the Minnesota River Basin well.



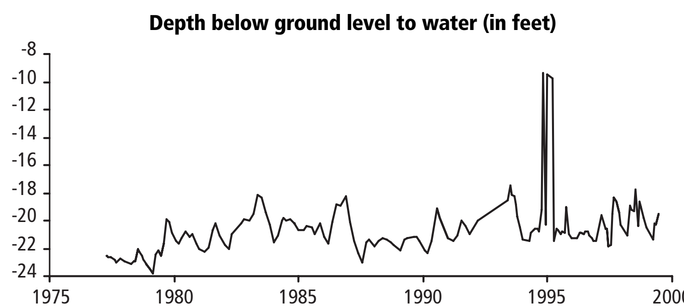
Note: The well measured in this graph is Obwell 64013, T112 R37 S21 CCC in Redwood County.

With slight water-level decline over the last 30 years, the well in the Upper Mississippi River Basin shows a seasonal variation due to nearby pumping for irrigation.



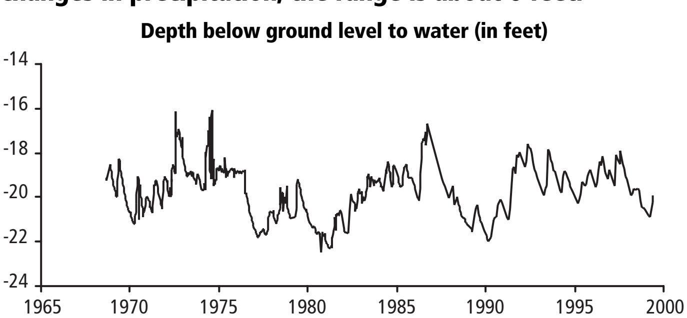
Note: The well measured in this graph is Obwell 49002, T39 R32 S1 BBB in Morrison County.

Climate and a nearby dam influence water levels in the Lower Mississippi River Basin well.



Note: The well measured in this graph is Obwell 19006, T112 R18 S8 ABA in Dakota County.

Water levels in the St. Croix River Basin well are related to changes in precipitation; the range is about 6 feet.



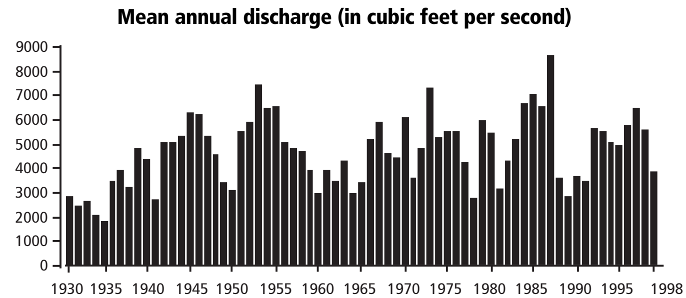
Note: The well measured in this graph is Obwell 58000, T45 R20 S26 DBB in Pine County.

Source: Department of Natural Resources

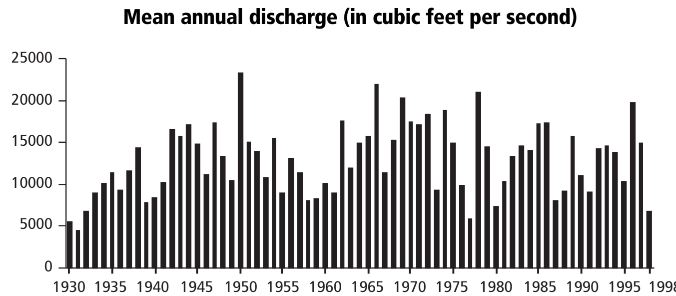
RIVER FLOWS FLUCTUATE GREATLY THROUGHOUT MINNESOTA DUE TO AMOUNT OF RAIN AND SNOW

In these seven stream-flow stations, water volumes are measured as they flow past a particular point. The drought of the 1930s is reflected by low flows. Since then, the overall flow trend has been relatively constant with expected annual fluctuations from changes in the climate. Differences from site to site are due to differences in the size of drainage areas, differences in characteristics such as land cover and development, and statewide climate variation.

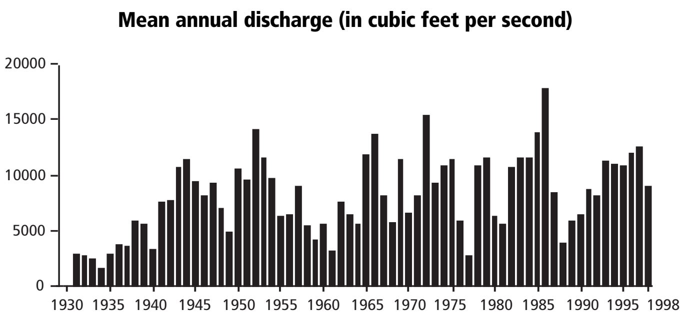
Repeated high and low flows are notable in the St. Croix River at St. Croix Falls. The drainage area is 6,240 square miles.



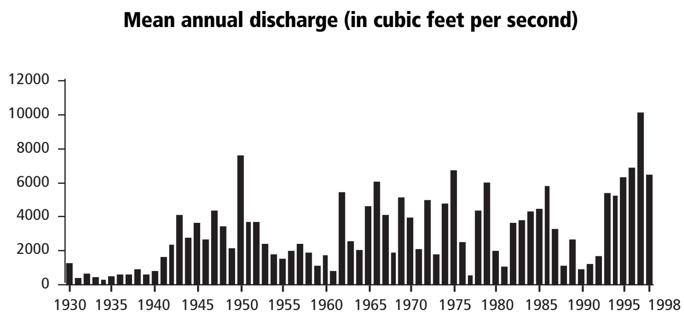
High and low flows in the Rainy River at Manitou Rapids differ from rivers further south in Minnesota. The drainage area is 19,400 square miles.



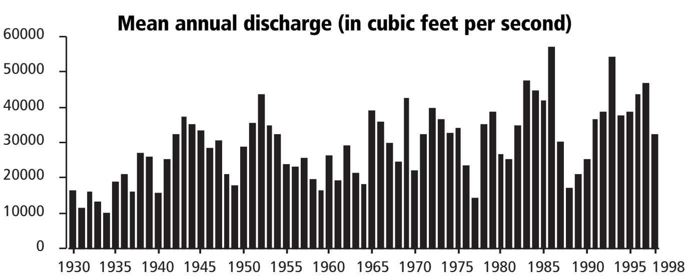
In the Mississippi River at Anoka — draining 19,100 square miles — periodic low and high water levels are similar to the patterns in the St. Croix.



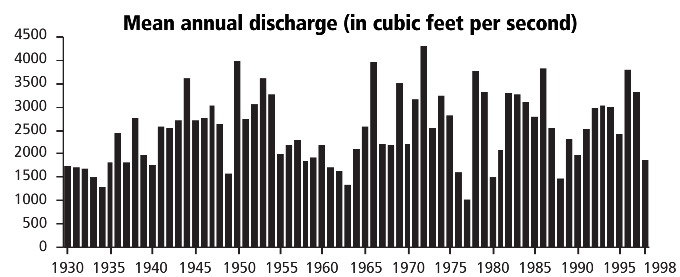
The record flood of 1997 is prominent in the Red River at East Grand Forks.The drainage area is 30,100 square miles.



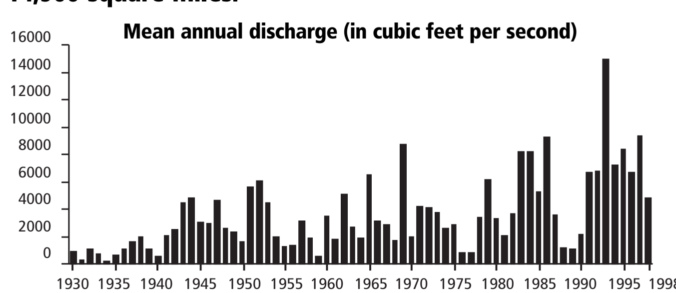
Draining 59,200 square miles, the flows measured in the Mississippi River at Winona are increasing due to increases in rain and snow.



Flows in the St. Louis River at Scanlon, in the Lake Superior Basin — draining 3,430 square miles — have increased due to added precipitation.

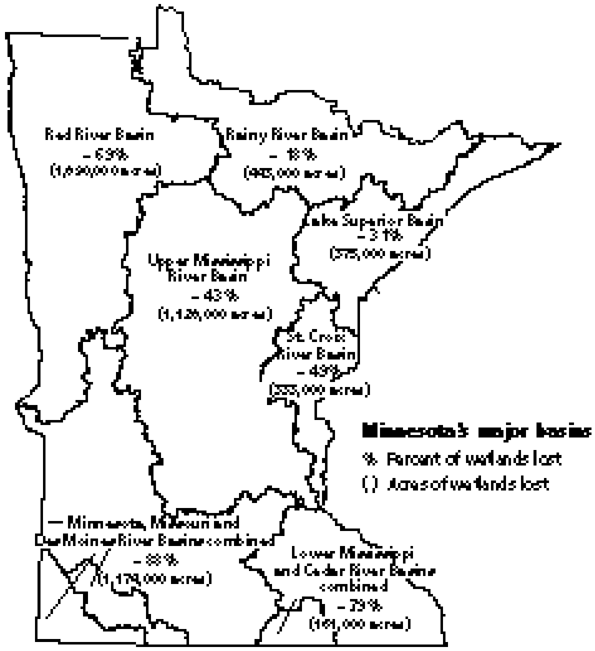


The flooding in 1993 from record rain and snow is apparent in the Minnesota River at Mankato. The drainage area is 14,900 square miles.



Source: Department of Natural Resources and U.S. Geological Survey

Significant amounts of wetlands have been lost in Minnesota since early 1900s



More than 5.5 million acres of wetlands have been lost since the early 1900s. The Red, Minnesota and Upper Mississippi basins account for most of the lost acreage.

Note: Wetland estimates are based on data collected between late 1800s and early 1900s and compared to data from late 1980s and early 1990s.

Source: Board of Water and Soil Resources

Objective E. Maintain flow of rivers and streams within historical range of variation

Again, demand needs to reflect the natural variation in supplies. When water use increases during drought, it can threaten other human, fish and wildlife needs. Costs increase as flood-prone lands are developed. Surface water is a valuable source of drinking water with 26 community water supplies using water from lakes or rivers and nearly one million drinking from Mississippi River sources.

Indicator 14. Trends in stream flow

Minnesota's water consumption is increasing even in years with plenty of precipitation. During drought, decreased flows can affect the ecological health of a stream. Power production and industrial processing are major users of surface water.

Stream flow is measured at approximately 96 continuous gauging stations and numerous measurement sites maintained by the U.S. Geological Survey. The Department of Natural Resources measures stream flow at 38 flood warning gauge sites. Additional measurements are taken by permit holders and researchers for high or low flow documentation. Models and statistical analyses describe the frequency and magnitude of flows and forecast high or low flows. Water users or property owners in the path of the water can then take appropriate action.

Objective F. Maintain the quality and diversity of Minnesota's lakes and wetlands while acknowledging regional variation

Wetlands are important because of how they function in hydrologic and ecological systems. While the value of lakes has been widely recognized, wetlands had for a long time been considered a nuisance and drained for development or farming. Regional differences in Minnesota can be attributed to the quantity of wetlands existing now and historically. Today there is greater understanding about the value of wetlands for habitat, water quality, flood mitigation and recreation.

Indicator 15. Wetland acres

Despite wetland gains from federal, state and private restoration efforts and regulatory programs such as the Wetland Conservation Act, it is unlikely that Minnesota has reached its goal of no-net-loss of wetlands. Significant wetland losses occur from activities that do not require approvals or permits, making them impossible to accurately track. As difficult as it is to estimate wetland gains and losses on an acreage basis, it is even more difficult to measure the functional gains and losses resulting from wetland projects. Quantitative information on wetland functions, which is more relevant than total acreage, is not available.

Goal: Minnesotans will restore and maintain healthy ecosystems that support diverse plants and wildlife

Managed ecosystems in which plant and animal diversity closely resemble that of undisturbed systems tend to be more resilient and stable, as well as more healthy. Because the natural environment can be modified by people’s activities, the diversity of plants and animals is a commonly used measure of ecosystem health. Naturally diverse systems have a variety of species, a variety of habitats, and a complex food web. As habitats or species are eliminated, relationships between species change and the system becomes more susceptible to decline and collapse. Exotic plants and animals tend to displace native species and may reduce diversity and disrupt normal ecosystem processes.

Objective G. Ensure that aquatic environments have conditions suitable for the maintenance of healthy self-sustaining communities of plants and animals.

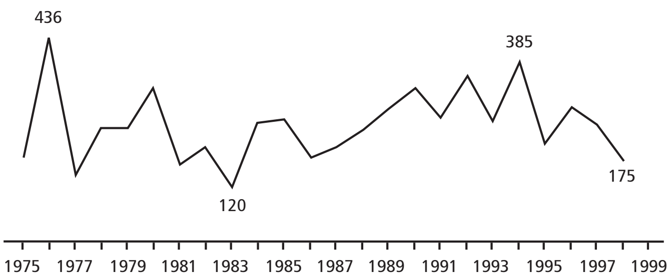
Several species are suggested to track the health of the ecosystem. Fish, frogs and some species of birds rely on water environments for food, cover and nesting areas. Variability of some species at a statewide scale may mask local areas where conditions have deteriorated for a species because of loss of habitat or overuse. If pollution affects food sources, it can affect reproduction, as was the case with the bald eagle's decline due to DDT, a pesticide now banned but commonly used before the 1970s.

DIVERSITY OF SPECIES IS A MEASURE OF ENVIRONMENTAL HEALTH

Tracking the diversity of plants and animals is a commonly used way to portray ecosystem health. As habitats or species decline, relationships between other species change. Exotic species, such as eurasian watermilfoil, reduce diversity.

Minnesota's blue-winged teal bird population has fluctuated greatly since 1975

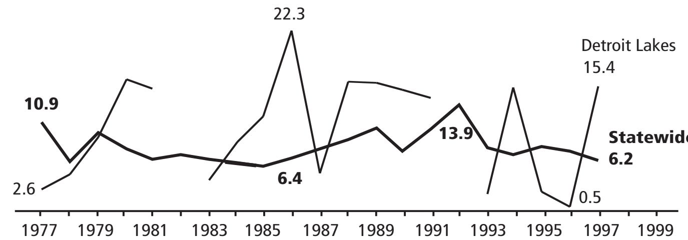
Adjusted population estimates (in thousands)



Estimates of Minnesota's blue-winged teal population reveal that following an initial downturn in the late '70s, the teal population grew until the mid-1990s before falling again in recent years. This recent trend may be due to the loss of habitat associated with the removal of land from the Conservation Reserve Program.

Long-term statewide walleye populations in unstocked lakes are relatively unchanged but sporadic in the Detroit Lakes area.

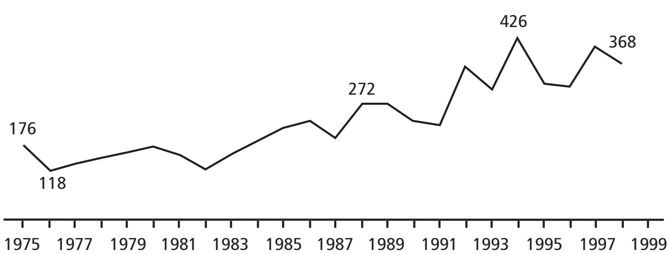
Catch per effort or the number of fish caught in a standard net test



Despite considerable annual variation, the walleye population appeared to grow until the early 1990s, but has since declined. Estimates for a single area, like Detroit Lakes, shows more variability due to the annual changes in local conditions such as fishing pressure, water temperatures and predator populations. No data was available for the walleye population in 1982 and 1992 in the Detroit Lakes area.

Minnesota's mallard breeding population has been on a steady rise since 1975

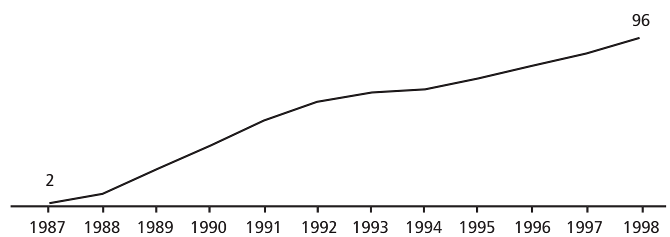
Adjusted adult mallard population estimates (in thousands)



The most likely reasons for the mallard increase are the natural fluctuations in populations combined with favorable spring weather, mild winters and light hunting harvest rates. Mallards are less sensitive to habitat loss than are many other species of waterfowl.

The estimated number of waterbodies infested with Eurasian watermillfoil has risen steadily since 1987

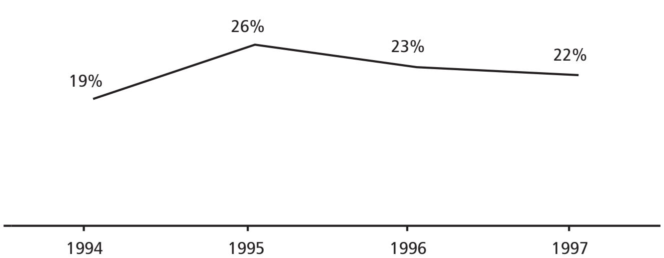
Statewide infested waterbodies



Eurasian watermillfoil has become a major concern in Minnesota due to its adverse effects on the health of lakes and rivers. Despite education efforts, the number of infested waterbodies has risen at a rapid rate since the late 1980s.

The proportion of lakes where juvenile loons were observed remained relatively constant between 1994 and 1997

Percent of lakes surveyed on which juvenile loons were observed



Loons are long-lived, and reproduction rates appear stable.

Source: Department of Natural Resources

Indicators 16 and 17. Blue-winged teal and mallard bird populations

These indicators were chosen because both the teal and mallard breed and reside in Minnesota waters and are highly dependent on ponds and wetlands that provide suitable food and cover. Population trends in waterfowl populations are related to many factors such as weather, predator populations and hunting mortality. However, land use decisions that affect the number of wetlands and quality of associated habitat are a primary determinant of waterfowl reproductive success. Changes in water quality that reduce the growth of waterfowl food plants and production of invertebrate foods in ponds and wetlands are also critical. Stable, resident, breeding populations of these two waterfowl species are indicative of the quantity and quality of the water resource. The trends in annual harvest of these species by hunters in particular geographic areas is a behavioral indicator that may have value for assessing environmental quality.

Data is available from the Department of Natural Resources. The increase of teal populations appear to be slowing possibly due to loss of habitat with decline of Conservation Reserve Program land. Mallards are less sensitive to habitat loss than many other species. Natural fluctuation in populations combined with favorable spring weather, mild winters and light harvest rates are some factors that can cause an increase. Trends in the prairie pothole region in western Minnesota are most significant.

Indicator 18. Percent of lakes where loons reproduce successfully

Loons are sensitive to disturbance and tend to favor northern lakes where disturbance is low, with abundant small fish for food and water clear enough that feeding can occur underwater. Reproductive success declines as disturbance increases and water clarity decreases.

Loons are counted on more than 600 lakes in eight counties by the Department of Natural Resources. Most Minnesota counties are in southern index areas containing marginal habitat for loons. The proportion of lakes on which juvenile loons were seen in 1995 to 1997 was fairly stable and slightly higher than in 1994.

Indicator 19. Number of territories occupied by bald eagles

Bald eagles are sensitive to environmental contaminants and need a habitat of healthy Minnesota waters. Their populations were decimated when reproduction was impaired by pesticides that accumulated in aquatic food chains. By eliminating the use of DDT pesticide, their numbers have increased slowly. At present, populations in Minnesota are healthy and continuing to increase but concern for their welfare is widespread. Because the bald eagle’s primary food is large fish, they are still at risk for exposure to contaminants in fish.

Data for 1973 to 1992 are available. In the future, surveys likely will be conducted every five years by the Department of Natural Resources. Both the number of territories occupied and the number of nests that successfully produced at least one young have increased steadily since 1975. The number of young produced per nest is adequate for a long-lived species.

Indicator 20. Frog and toad populations

Frogs and toads depend on a combination of water and land habitats and may be particularly sensitive to habitat degradation, acid rain and snow, and toxic chemicals in the environment. Changes in the number and location of amphibians, such as frogs and toads, are an indirect measure of overall environmental quality.

There is little statewide information on the population status of frogs and toads. The state of Wisconsin's shoreland management program, however, found drastic reductions in the abundance of green frogs on developed shorelands. In Minnesota, recent widespread frog malformations signal a change in environmental quality.

Indicator 21. Aquatic invertebrate population

Aquatic invertebrates are sensitive to environmental stressors such as changes in the chemical composition of sediment and water, increases in silt and pollutants, alterations in habitat and introduction of exotic species. These pressures cause changes in community structure and species composition and consequently, are indicators of biological quality at a particular site. Repeated sampling over the years can show trends in environmental quality.

Aquatic invertebrates species respond relatively rapidly to changes in their environment. Invertebrates collected from streams or wetlands provide data to calculate an *index of biotic integrity*. This index combines data on various measures such as species richness, predator composition and tolerance to pollution. The Minnesota Pollution Control Agency is developing indexes for both invertebrates and fish and has launched a biological monitoring program for rivers and streams across the state.

Indicator 22. Walleye population

The long-term abundance of particular fish species and the species composition of the fish community in a water body (that is, the different types of fish that live together) are indicative of water quality and the suitability of habitat. Most often, long-term declines of a particular species are due to loss of spawning and nursery habitat, but there can be other factors such as water quality degradation and excessive fishing.

Since it is not feasible to measure absolute numbers of fish in a given lake, indices of abundance are used to monitor changes in numbers through time. The most common index used in Minnesota is number of fish caught in a standard test net. This index makes it possible to compare numbers of fish in different locations and at different times. The Department of Natural Resources surveys important fishing lakes on a regular basis. Unstocked lakes are used to determine how species sustain themselves through natural reproduction, which is strongly linked to environmental quality.

Annual variations of statewide walleye populations in unstocked lakes has fluctuated from about six to 14 per test net. Despite annual variations in the estimated number of walleye and declining numbers since 1992, the long-term trend between 1977 and 1997 is flat or slightly upwards. Estimates for a single location or area, like the Detroit

Lakes area, show more variability over time in part because walleye numbers are influenced by local conditions, such as fishing pressure, water temperatures and predator populations. These conditions are difficult to pinpoint when local estimates are averaged over large areas.

Objective H. Limit introduction and spread of exotic species

As ecosystems are degraded by unwise, excessive use and the introduction of exotic species, desired native species of plants and animals are reduced or eliminated and economic losses are likely.

Indicator 23. Number of water bodies with Eurasian watermilfoil

The number of water bodies with Eurasian watermilfoil is an indicator of the rate of spread and potential disturbance to natural aquatic communities. It is also an indicator of the effectiveness of education and enforcement efforts that are designed to prevent accidental spread by anglers and boaters. Preventing the spread of Eurasian watermilfoil is crucial because eradication is usually not feasible. The Department of Natural Resources collects trend information.

Indicator 24. Miles of waterways and number of lakes and reservoirs with zebra mussels

Zebra mussels are small shellfish that have spread rapidly in Minnesota water since 1992. The miles of waterways with zebra mussels is an indicator of the rate of spread and potential disturbance to natural aquatic communities. The number of lakes and reservoirs with zebra mussels is also an indicator of potential spread of this species. Because the zebra mussel has a free-floating larval stage, it reproduces only where lakes or reservoirs are available. Education and enforcement efforts are designed to control the spread by anglers, boaters and commercial navigation interests. The zebra mussel displaces native species but also clogs city and industrial water intake pipes. The economic strain on certain industries and communities can rapidly occur.

There is no trend data on zebra mussels. Known zebra mussel populations are located in Lake Superior; the Mississippi River, downstream of St. Anthony Falls; and the St. Louis River, downstream of the Fond du Lac dam. Densities of up to 20,000 per square meter have been measured in Lake Pepin. Expansion of zebra mussels occurs at a very rapid rate. Zebra mussels made their way out of Lake Michigan into the Mississippi River basin via the Chicago Sanitary Shipping Canal in 1992. By the end of the season in 1992, zebra mussels had become established in isolated populations as far north as Minneapolis.

Goal: Minnesotans will have reasonable and diverse opportunities to enjoy the state's resources

Minnesota has a long tradition and policy of public access to state water resources, promoting use and enjoyment by all citizens, including those who do not own waterfront property. The number of public access sites and fishing piers reflect the state's abundant recreational opportunity; however, there is a pressing need to balance recreational use and water protection. Registered boats in the state have increased from 157,767 in 1959 to 780,680 in 1998. Registration of personal watercraft has grown from 55 in 1974 to 30,013 in 1998. Despite level sales of fishing licenses since 1991, fishing demands have continued to increase statewide.

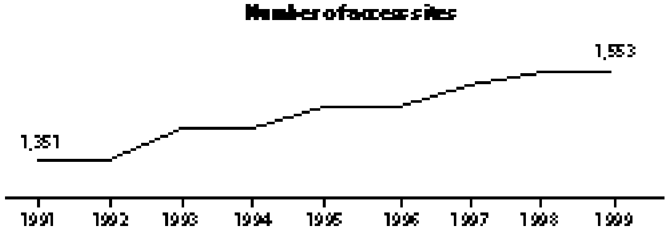
Objective I. Provide appropriate access to water based recreation sites

Water access sites include boat accesses, fishing piers, shore fishing areas and stream corridor easements. In addition to these sites, the public also has access to shorelines in other settings including state parks, state forests, national forests, national parks, local parks and other public holdings. The Department of Natural Resources collects trend information for all indicators under this objective.

Indicator 25. Number of sites for boat launching

The number of sites for boat launching is an indicator of how well the state is meeting its policy of providing access to public waters. The number of sites has grown from 1,000 in 1979, to 1,250 in 1989, to 1,550 in 1999. Minnesota ranks third in the nation in total boats registered (768,000) and first in the number of boats per capita, one for every six people. Minnesotans rely heavily on public water access sites. About 75 percent of state boat owners launch at public access sites at least once a year. The long-term goal is to provide access to all significant recreational waters of the state.

Boat access in Minnesota has increased since 1991



During the 1990s, Minnesota has increased the number of boat launches at a steady rate in an effort to increase the availability of Minnesota's water resources to citizens and visitors.

Source: Department of Natural Resources

Indicator 26. Number of public fishing piers

Providing angling opportunity to children, people with disabilities, senior citizens and people who do not have the means to fish from boats is especially important in urban areas that have fishing lakes. The number of public fishing piers is an indicator of how well this need is being met. In 1979 there were few public fishing piers on Minnesota waters; the number climbed to 60 in 1989, and reached 415 in 1999. Most of these piers are built through a cooperative local-state effort.

Indicator 27. Miles of stream corridor easements

Stream corridor easements give the public the right of way to streams. Fishing on smaller streams, and in particular on trout streams, is best from in the stream, or the corridor. In addition to providing the necessary access for angling, stream corridor easements allow habitat management to protect valuable vegetation on stream banks. The number of miles of easements is an indicator of angling opportunity on smaller streams. For example, Minnesota currently has 216 miles of easements on trout streams, but nearly 1,000 miles of trout streams lack access.

Objective J. Improve or maintain the quality of water recreation

Enjoyment and safety decline on waters subject to heavy recreational use. In recent years the Department of Natural Resources has conducted surveys of boaters to measure their satisfaction and levels of use. Fishing surveys are also conducted to determine the amount and rate of fish harvest. To prevent recreational-use conflicts, surface water use regulations now apply to about 300 separate waters. Fish harvest regulations address the management needs of about 100 lakes and 30 rivers.

Indicator 28. Boater satisfaction by surveys

The satisfaction of boaters is an indicator of the recreational quality of state lakes and rivers and helps define specific problems. Surveys allow the state to compare regions and to track recreation over time in regions where studies have been repeated.

In the north central lake region, there are nearly 300,000 acres of boating water on 205 major recreational boating and fishing lakes. In 1998, 79 percent of the lakes had at least minimal public access, up from 66 percent in 1985. Approximately 28 percent of boats on the water launch from a public access point, 23 percent from commercial access and 49 percent from other sources (primarily residents living near the shore). Between 1985 and 1998, the number of boats on lakes did not change significantly. In contrast, more boaters perceived lakes to be crowded in 1998 (15 percent) than in 1985 (5 percent). Overall, satisfaction with boating experiences is high. Over half of all boaters report being ‘very satisfied’ while another 40 percent report being ‘satisfied.’ Only 10 percent were ‘dissatisfied.’

In the Twin Cities metropolitan area, there are nearly 74,000 acres of boating water on two large rivers and 102 lakes over 100 acres in size. The St. Croix River and Lake Minnetonka account for approximately 43 percent of boating in the area. In 1996, 94 percent of these acres had at least minimal public access, up from 91 percent in 1984.

The number of boats on the water changed little between 1984 and 1996. The intensity of boating (measured as boats per acre of water) is four to five times higher than in the central lake region (Crow Wing and Cass counties) or the west lakes region (Douglas, Otter Tail and Becker counties). Approximately 14 percent of boaters considered conditions ‘crowded’ while 5 percent considered conditions ‘far too crowded.’

Regional studies of boating have been conducted by the Department of Natural Resources in west central Minnesota in 1986, north central in 1985 and 1998, central in 1987 and the metropolitan area in 1984 and 1996.

Indicator 29. Angler satisfaction by surveys

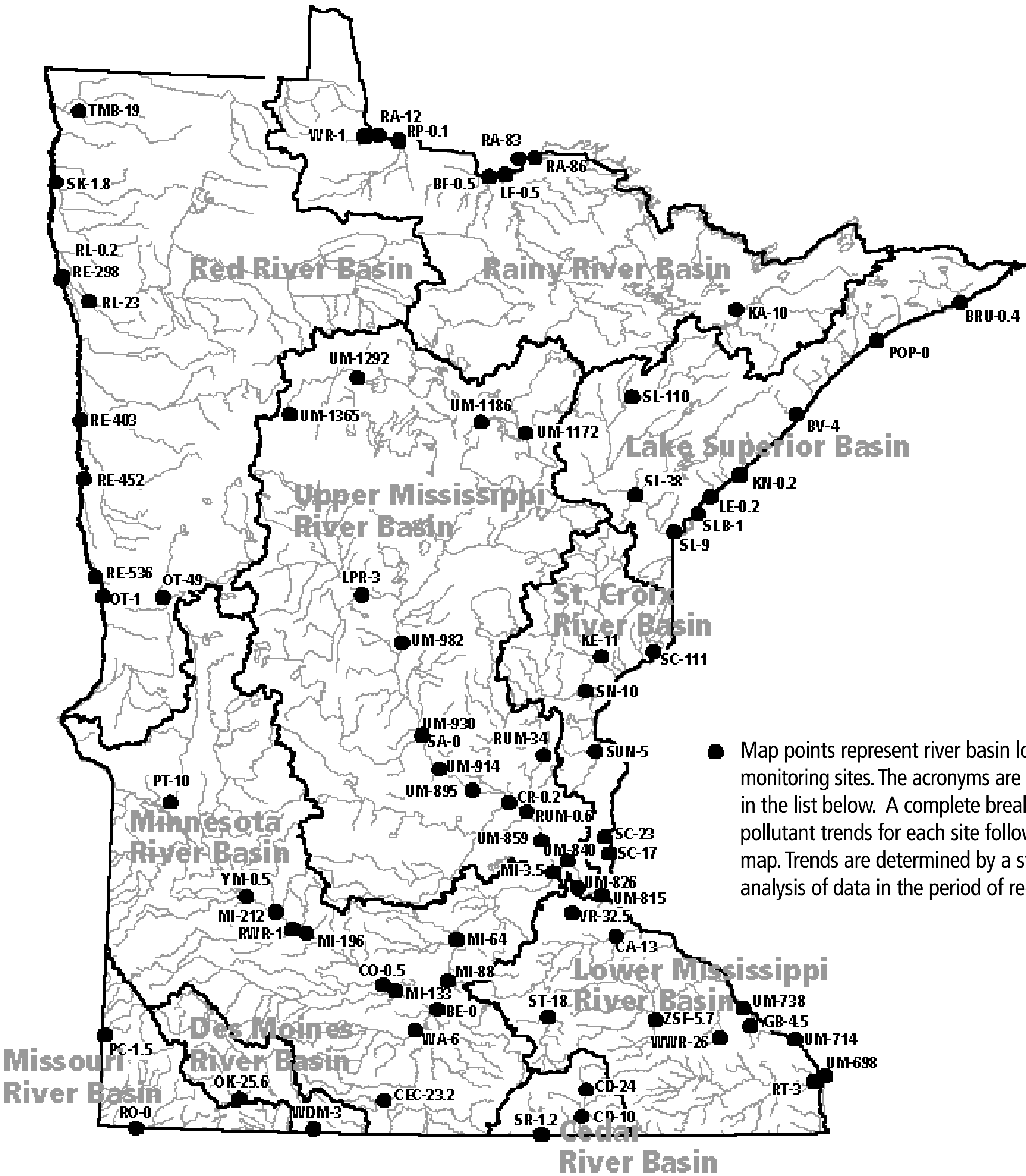
Angler surveys are conducted by the Department of Natural Resources to determine the amount of fishing activity and level of harvest on individual waters. This information helps the department determine if harvest is sustainable. Some of the larger, more important lakes such as Mille Lacs are continually surveyed for fishing pressure and harvest. The state’s 11 largest lakes are usually surveyed annually and other waters are checked less frequently. This data also helps measure ecosystem health.

Recreational fishing pressure on Minnesota waters is highly variable. In general, fishing pressure per acre is low on very large and on remote lakes. Conversely, fishing pressure is high on smaller lakes and lakes near metropolitan areas. Fishing pressure on walleye lakes has increased steadily since the 1950s. For walleye, the number and weight of fish caught has remained steady as fishing pressure increased, but the amount of time needed to catch a fish has increased. For northern pike, the number and weight of fish caught and the time needed to catch a fish tends to decrease as fishing pressure increases.

Of approximately 5,000 lakes managed for sport fishing, 918 lakes were surveyed from 1935 to 1994. Most angler surveys have been conducted on lake trout lakes and walleye lakes. Relatively few lakes have multi-season (summer and winter) repetitive surveys.

APPENDIX

River basin long-term monitoring sites



● Map points represent river basin long-term monitoring sites. The acronyms are explained in the list below. A complete breakdown of pollutant trends for each site follows this map. Trends are determined by a statistical analysis of data in the period of record.

BE=Blue Earth River
BF=Big Fork River
BRU=Brule River
BV=Beaver River
CA=Cannon River
CD=Cedar River
CEC=Center Creek
CH=Chippewa River
CO=Cottonwood River
CR=Crow River
GB=Garvin Brook
KA=Kawishiwi River
KE=Kettle River
KN=Knife River
LE=Lester River
LF=Little Fork River
LPR=Long Prairie River
MI=Minnesota River
OK=Okabena Creek
OT=Ottertail River
PC=Pipestone Creek
POP=Poplar River
PT=Pomme deTerre River
RA=Rainy River
RE=Red River
RL=Red Lake River
RO=Rock River
RP=Rapid River
RT=Root River
RUM=Rum River
RWR=Redwood River
SA=Sauk River
SC=St. Croix River
SK=Snake River
SL=St. Louis River
SLB=St. Louis Bay
SN=Snake River
SR=Shell Rock River
ST=Straight River
SUN=Sunrise River
TMB=Two River (Middle Branch)
UM=Upper Mississippi River
VR=Vermillion River
WA=Watonwan River
WDM=Des Moines River (West Fork)
WR=Winter Road River
WWR=Whitewater River
YM=Yellow Medicine River
ZSF=Zumbro River (South Fork)

Pollutant trends at river long-term monitoring sites

Basin Station		Biochemical Oxygen Demand	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Unionized Ammonia	Fecal Coliforms
Big Sioux River							
PC-1.5	(1963 – present)	decrease	no trend	decrease	increase	decrease	decrease
Cedar Des Moines River							
CD-10	(1967 – present)	decrease	no trend	decrease	increase	decrease	decrease
CD-24	(1967 – present)	decrease	no trend	decrease	no trend	decrease	no trend
OK-25.6	(1973 – present)	decrease	insuf data	increase	increase	decrease	insuf data
SR-1.2	(1961 – present)	decrease	decrease	no trend	increase	decrease	no trend
WDM-3	(1967 – present)	no trend	no trend	decrease	increase	decrease	decrease
Lake Superior							
BRU-0.4	(1973 – present)	decrease	insuf data	decrease	insuf data	insuf data	insuf data
BV-4	(1973 – present)	no trend	decrease	decrease	no trend	increase	decrease
KN-0.2	(1973 – present)	insuf data	decrease	decrease	increase	insuf data	decrease
LE-0.2	(1973 – present)	insuf data	decrease	decrease	insuf data	insuf data	decrease
POP-0	(1973 – present)	insuf data	insuf data	decrease	insuf data	increase	insuf data
SLB-1	(1974 – present)	decrease	decrease	decrease	decrease	no trend	decrease
SL-9	(1953 – present)	decrease	decrease	decrease	no trend	decrease	decrease
SL-38	(1953 – present)	decrease	no trend	decrease	no trend	decrease	decrease
SL-110	(1967 – present)	decrease	no trend	decrease	no trend	no trend	decrease
Lower Portion Upper Mississippi							
CA-13	(1953 – present)	decrease	decrease	decrease	no trend	decrease	decrease
GB-4.5	(1981 – present)	decrease	no trend	no trend	increase	decrease	no trend
RT-3	(1958 – present)	decrease	no trend	decrease	increase	decrease	decrease
ST-18	(1955 – present)	decrease	no trend	decrease	no trend	decrease	decrease
UM-698	(1958 – present)	decrease	no trend	decrease	increase	decrease	no trend
UM-714	(1962 – present)	decrease	decrease	decrease	no trend	decrease	decrease
UM-738	(1974 – present)	decrease	no trend	decrease	increase	decrease	no trend
UM-815	(1958 – present)	decrease	no trend	decrease	increase	decrease	decrease
UM-826	(1975 – present)	decrease	increase	decrease	increase	decrease	decrease
UM-840	(1973 – present)	decrease	increase	no trend	increase	decrease	decrease
VR-32.5	(1981 – present)	increase	decrease	no trend	increase	decrease	no trend
WWR-26	(1974 – present)	decrease	no trend	no trend	increase	decrease	no trend
ZSF-5.7	(1973 – present)	decrease	no trend	decrease	increase	decrease	no trend
Minnesota River							
BE-0	(1967 – present)	decrease	no trend	decrease	increase	decrease	decrease
CEC-23.2	(1974 – present)	decrease	no trend	decrease	increase	decrease	decrease
CO-0.5	(1967 – present)	decrease	no trend	no trend	increase	decrease	decrease
MI-3.5	(1974 – present)	decrease	no trend	no trend	no trend	decrease	no trend
MI-64	(1955 – present)	decrease	no trend	decrease	no trend	decrease	decrease
MI-88	(1955 – present)	decrease	no trend	decrease	no trend	decrease	decrease
MI-133	(1957 – present)	decrease	no trend	decrease	increase	decrease	decrease
MI-196	(1967 – present)	decrease	no trend	decrease	increase	decrease	decrease
MI-212	(1957 – present)	insuf data	insuf data	insuf data	increase	decrease	insuf data
PT-10	(1971 – present)	decrease	decrease	decrease	increase	decrease	decrease
RWR-1	(1974 – present)	decrease	no trend	decrease	increase	decrease	no trend
WA-6	(1968 – present)	decrease	no trend	decrease	increase	decrease	decrease
YM-0.5	(1967 – present)	decrease	no trend	no trend	increase	decrease	decrease

Basin Station		Biochemical Oxygen Demand	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Unionized Ammonia	Fecal Coliforms
Missouri River							
RO-0	(1962 – present)	decrease	no trend	decrease	increase	decrease	no trend
BF-0.5	(1971 – present)	insuf data	decrease	decrease	increase	insuf data	decrease
KA-10	(1967 – present)	decrease	decrease	decrease	no trend	no trend	decrease
LF-0.5	(1971 – present)	insuf data	insuf data	insuf data	increase	insuf data	decrease
RA-12	(1958 – present)	decrease	decrease	decrease	increase	no trend	decrease
RA-83	(1953 – present)	decrease	decrease	decrease	increase	no trend	decrease
RA-86	(1974 – present)	decrease	decrease	decrease	increase	insuf data	insuf data
RP-0.1	(1971 – present)	insuf data	decrease	decrease	increase	decrease	insuf data
WR-1	(1958 – present)	insuf data	insuf data	decrease	increase	decrease	insuf data
Red River							
OT-1	(1953 – present)	decrease	no trend	decrease	increase	decrease	decrease
OT-49	(1967 – present)	decrease	decrease	decrease	insuf data	decrease	decrease
RE-298	(1995 – present)	decrease	no trend	no trend	increase	decrease	decrease
RE-403	(1967 – present)	decrease	no trend	no trend	increase	no trend	decrease
RE-452	(1971 – present)	no trend	increase	no trend	increase	decrease	decrease
RE-536	(1953 – present)	no trend	no trend	no trend	increase	decrease	decrease
RL-0.2	(1953 – present)	decrease	decrease	decrease	no trend	decrease	decrease
RL-23	(1955 – present)	decrease	insuf data	decrease	insuf data	decrease	decrease
SK-1.8	(1971 – present)	decrease	insuf data	insuf data	insuf data	decrease	insuf data
TMB-19	(1971 – present)	decrease	insuf data	decrease	insuf data	decrease	decrease
St. Croix River							
KE-11	(1967 – present)	decrease	decrease	decrease	no trend	decrease	decrease
SC-17	(1967 – present)	decrease	decrease	decrease	increase	no trend	decrease
SC-23	(1953 – present)	decrease	decrease	decrease	insuf data	insuf data	decrease
SC-111	(1957 – present)	decrease	decrease	decrease	no trend	no trend	decrease
SN-10	(1971 – present)	decrease	decrease	decrease	insuf data	insuf data	decrease
SUN-5	(1974 – present)	decrease	insuf data	insuf data	insuf data	increase	insuf data
Upper Portion Upper Mississippi							
CR-0.2	(1953 – present)	decrease	no trend	no trend	increase	decrease	decrease
LPR-3	(1974 – present)	no trend	no trend	no trend	increase	decrease	decrease
RUM-0.6	(1953 – present)	decrease	decrease	decrease	insuf data	insuf data	decrease
RUM-34	(1955 – present)	decrease	decrease	decrease	increase	decrease	decrease
SA-0	(1953 – present)	no trend	no trend	no trend	no trend	decrease	decrease
UM-859	(1953 – present)	decrease	no trend	decrease	increase	decrease	decrease
UM-895	(1976 – present)	no trend	no trend	decrease	increase	decrease	no trend
UM-914	(1967 – present)	decrease	no trend	no trend	increase	no trend	decrease
UM-930	(1953 – present)	decrease	decrease	decrease	increase	decrease	no trend
UM-982	(1967 – present)	decrease	no trend	decrease	increase	decrease	decrease
UM-1172	(1974 – present)	decrease	no trend	decrease	increase	decrease	decrease
UM-1186	(1967 – present)	decrease	decrease	decrease	increase	decrease	decrease
UM-1292	(1967 – present)	decrease	decrease	decrease	increase	decrease	decrease
UM-1365	(1965 – present)	decrease	decrease	decrease	increase	decrease	decrease
Monitoring sites (having sufficient data) showing:							
Decreasing pollutant trend		78%	34%	71%	1%	71%	70%
Increasing pollutant trend		1%	4%	1%	63%	4%	0%
No trend		9%	48%	20%	20%	11%	16%

Note: The years in parentheses after the station number represent the time frame in which data was collected.

Glossary

Amphibians: Organisms such as frogs, toads and salamanders that live in two worlds during their life. Most amphibians live on land, but lay their eggs in water. The adult amphibians have internal lungs instead of external gills.

Aquatic invertebrates: Animals without a backbone or spinal column that are found in lakes, streams, ponds, marshes and puddles. They help maintain the health of the water ecosystem by eating bacteria and dead, decaying plants and animals.

Aquifer: A sand, gravel or rock formation capable of storing or conveying water below the surface of the land.

Best management practice: Voluntary practices used to prevent or minimize sources of nonpoint pollution.

Biochemical oxygen demand: Measures the amount of oxygen demanded by decomposition and respiration as organic matter contained in a given sample or body of water is consumed.

Conservation Reserve Program: A U.S. Department of Agriculture program started in 1986 that offers 10-year subsidies to stop crop production on heavily eroding land.

Ecosystem: A community of plants and animals and the physical and chemical environment in which it exists.

Exotic species: Nonnative species that adversely affect native species.

Erosion: The wearing away of land surface by water or wind. It occurs naturally from weather or runoff, but often is intensified by human activities.

Fecal coliform: Present in the intestines of humans and other animals. If found in water resources, indicates sewage contamination has occurred and suggests the presence of disease-causing bacteria and viruses.

Hydrograph: A graph showing the water elevation measured over a period of time. Ground water elevation is often reported as the depth below ground surface to that point.

Karst or karst terrain: Topography of fractured or channeled limestone, dolomite or gypsum, formed by the dissolution of these rocks by rain and underground water. Karst topography, largely found in southeast Minnesota, is characterized by closed depressions, sinkholes and underground drainage.

Nitrogen: Nitrogen gas, nitrate, nitrite and ammonia are forms of nitrogen related through a complex cycle. For example, nitrate is the most common form of nitrogen in oxygenated water; however, when little of no oxygen is present, the ammonium ion may remain stable.

Nonpoint pollution: Pollution that arises from diffuse sources such as runoff from cultivated fields or urban areas.

Nutrients: Elements or compounds essential to growth. Phosphorus and nitrogen are the two most common nutrients in runoff that threaten water resources. Sources include fertilizer and human and animal waste.

Pesticide: A chemical substance used to kill or repel pests. Pesticides include herbicides to kill weeds, insecticides to kill insects and fungicides to kill fungi.

Phosphorus: A chemical element that is necessary for algal growth. Sources include fertilizer, animal and human waste and plant matter.

River basin: The surrounding land area that drains into a river or river system.

Secchi transparency: A measure of water clarity that also could provide an indirect measure of the amount of algae in the water.

Suspended solids: Particles of such things as dirt, plants and animals in water that decrease the amount of light available for aquatic life, making it difficult for fish and other aquatic animals to breathe and feed. Erosion is a major cause of solids.

Sustainable development: Development that enhances economic opportunity and community well-being while protecting and restoring the natural environment.

Volatile organic compounds: Chemicals contained in a variety of commercial, industrial and household products that can evaporate rapidly from water into air at normal temperatures.

Watershed: The surrounding land area that drains into a lake, river or river system.

Water table: The top of an unconfined aquifer; indicates the level at which soil and rock are saturated with water. From the water table, water can move downward into underlying aquifers, laterally toward lakes and streams, or upwards into the roots of plants

Wetlands: Low-lying lands that frequently have standing water on them, such as swamps, marshes and meadows.

EQB Water Resources Committee

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Patrick Brezonik, University of Minnesota Water Resources Center
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Ron Harnack, Board of Water and Soil Resources
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Tim Scherkenbach, Pollution Control Agency
David Southwick, Minnesota Geological Survey

Water Management Unification Task Force

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David Southwick, Bob Tipping: Minnesota Geological Survey
Judy Sventek, Metropolitan Council
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Basin Teams

Lake Superior Basin: Brian Fredrickson, Pollution Control Agency, chair; Joel Peterson, PCA, vice chair; Mark Nelson, Board of Water and Soil Resources, vice chair; B. Kevin Daw (primary), Kelly Voigt (alternate); Natural Resources Conservation Services; Mark Dittrich or Mark Zabel, Department of Agriculture; Beth Kluthe, Department of Health; Mark Nelson, BWSR; Roger Nelson, PCA; Dan Retka, Department of Natural Resources

Lower Mississippi and Cedar River Basins: Mark Dittrich, Agriculture, co-chair; Norm Senjem, PCA; co-chair; John Nicholson (primary), Mark Kunz (alternate), NRCS; Art Persons, Health; Dave Peterson, BWSR; Walt Popp, DNR; Judy Sventek, Metropolitan Council; Mark Zabel, Agriculture

Minnesota, Des Moines and Missouri River Basins: Terry Bovee, Health, co-chair; Larry Gunderson, PCA, co-chair; Mike Appel (primary), Ann English (alternate), NRCS; Mark Dittrich or Mark Zabel, Agriculture; Jack Frost, Met Council; Mark Hanson, PCA; Cheryl Heide, DNR; Chris Hughes, BWSR; Dave Leuthe, DNR

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Red River Basin: Brian Dwight, BWSR, co-chair; Lisa Scheirer, PCA, co-chair; Nolan Baratono, PCA; Mark Dittrich or Mark Zabel, Agriculture; Mike Howe, Health; Glen Kajewski (primary), Jim Ayres (alternate), NRCS; Paul Swenson, DNR

St. Croix River Basin: Keith Grow, BWSR, co-chair; Dale Homuth, DNR, co-chair; Tori Boers, Met Council; Mark Dittrich or Mark Zabel, Agriculture; Mike Howe, Health; Rita O'Connell, PCA; Harvey Sundmacker (primary), B. Kevin Daw (alternate), NRCS

Upper Mississippi River Basin: Jim Hodgson, PCA, co-chair; Dan Steward, BWSR, co-chair; Jim Ayres (primary), Harvey Sundmacker (alternate), NRCS; C. B. Bylander, DNR; Mark Dittrich or Mark Zabel, Agriculture; Beth Kluthe, Health; Judy Sventek, Metropolitan Council

Because four basins affect the Twin Cities region and the area contains large numbers of people and water-related groups, a **Metro Committee** has been formed to help gather input in this area. The committee includes: Steve Woods, BWSR, co-chair; Jack Frost, Met Council, co-chair; Judy Sventek (alternate co-chair); Wayne Barstad, DNR; Tori Boers, Met Council; Art Persons, Health; Glenn Skuta, PCA; Harvey Sundmacker (primary), Ed Musielewicz (alternate), NRCS

Minnesota Planning is a state agency charged with developing a long-range plan for the state, stimulating public participation in Minnesota's future and coordinating activities with state agencies, the Legislature and other units of government.

The Environmental Quality Board, staffed by Minnesota Planning, draws together five citizens and the heads of 10 state agencies that play a vital role in Minnesota's environment and development. The board develops policy, creates long-range plans and reviews proposed projects that would significantly influence Minnesota's environment.

This *Public Review Draft — Preparing for Minnesota Water Plan 2000* was developed by the EQB Water Resources Committee and the Water Management Unification Task Force and prepared by committee director Marilyn Lundberg at Minnesota Planning. Barbara Blackstone, Office of Dispute Resolution, facilitated the meetings to develop this draft report.

Upon request, this *Public Review Draft* will be made available in an alternative format, such as Braille, large print or audio tape. For TTY, contact Minnesota Relay Service at 800-627-3529 and ask for Minnesota Planning.

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