

Land Use Recommendations Table of Contents

Introduction..... 99

Community Land Use..... 99

Land Use Recommendation 1: Fund and implement a state land use, development, and investment guide..... 102

Land Use Recommendation 2: Support local and regional conservation-based community planning. 104

Land Use Recommendation 3: Ensure protection of water resources in urban areas by evaluating and improving current programs..... 108

Agricultural Land Use..... 114

Land Use Recommendation 4: As much as possible, transition renewable fuel feedstocks to perennial crops..... 119

Land Use Recommendation 5: Reduce stream-bank erosion through reductions in peak flows..... 122

Land Use Recommendation 6: Reduce upland and gully erosion through soil conservation practices..124

Land Use Recommendation 7: Enable improved design and targeting of conservation through improved and timely data collection and distribution..... 127

Forestry Land Use.....128

Land Use Recommendation 8: Protect large blocks of forested land..... 130

Land Use Recommendation 9: Assess tools for forest land protection..... 131

Land Use Recommendation10: Support and expand sustainable practices on working forested lands.131

The following icons are used throughout the plan recommendations by type:



Integrated Planning Recommendations



Critical Land Protection Recommendations



Land and Water Restoration and Protection Recommendations



Sustainable Practices Recommendations



Economic Incentives for Sustainability

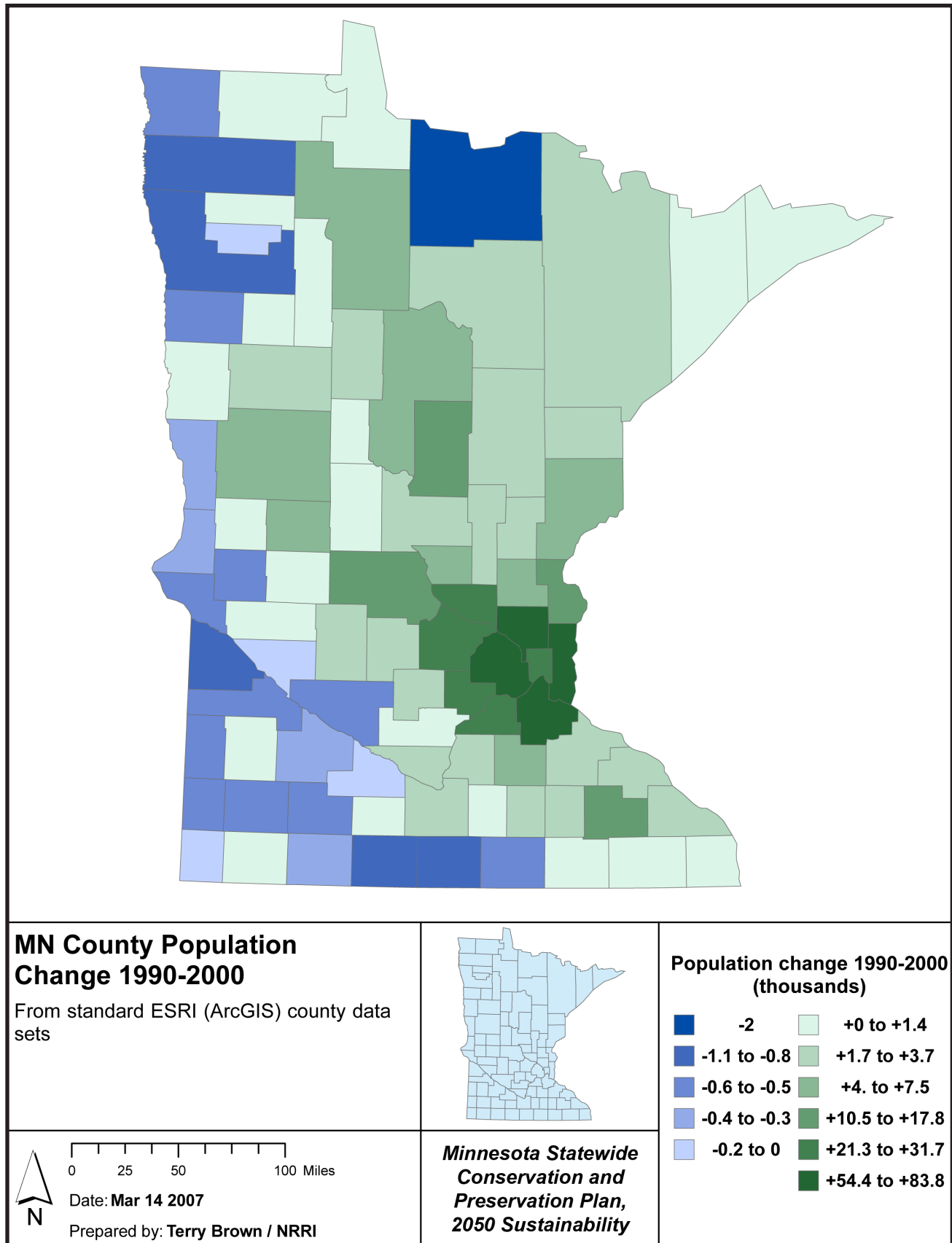


Figure L1. Minnesota county population change, 1990–2000. Credit: Terry Brown, NRRI.

LAND USE

Recommendations

Introduction

How land is used to support human activities has both direct and indirect effects on all natural resource systems. The interacting components of land use are complex and diverse, and can have economic as well as environmental consequences. Interrelationships between different uses, patterns and density of development, and agricultural and forestry practices all combine to have major effects not only on land, wildlife, water, and other natural resources, but also on energy consumption and transportation, which in and of themselves have natural resource effects.

The land use team was charged with examining the following questions:

1. What public and private land use choices are needed to improve environmental quality, and to anticipate and adapt to environmental change in Minnesota?
2. What sustainable policy and investment decisions should be made to support these choices?

The team addressed three topics that reflect types of land use in the state—community (development), agriculture, and forestry. Each of these three topics is addressed separately in this report; however, they are clearly interconnected. Community, agricultural, and forested lands are all intertwined on the state landscape, and decisions about one often affect the others. Some trends affect these topics individually, and others, such as climate change, affect natural resources across all land use types.

Community Land Use

One of the greatest threats to Minnesota's natural resources is the expansion of urban and developed areas. Development is the conversion of native land, shoreland, agricultural land, or forestlands into housing, industrial/commercial areas, or transportation corridors. In simple terms, development usually entails three components: removal of what was originally there, such as land cover; alteration of topography; and establishment of new features, such as roads and buildings. These actions impact natural resources on a dramatic level. In addition, the pattern of the new features (e.g., compact versus low-density development) continues to affect natural resources for generations to come.

Key Natural Resource Conditions and Trends in Community Land Use

Over the next 20 years, population in the Twin Cities metropolitan area is expected to increase by more than 1 million people (Figure L1). These people will need places to live, work, and recreate, and transportation to move from place to place. The Twin Cities are not the only location for population growth in the state. Development is occurring all over Minnesota in not only urban and suburban areas, but also in rural areas. This is resulting in rapid and significant changes in land cover. Development has resulted in an increase in impervious surface area such as roads and parking lots, particularly in the Twin Cities metropolitan area (Figures L2 and L3). As urban development has expanded, so has the number of miles driven and commute time.

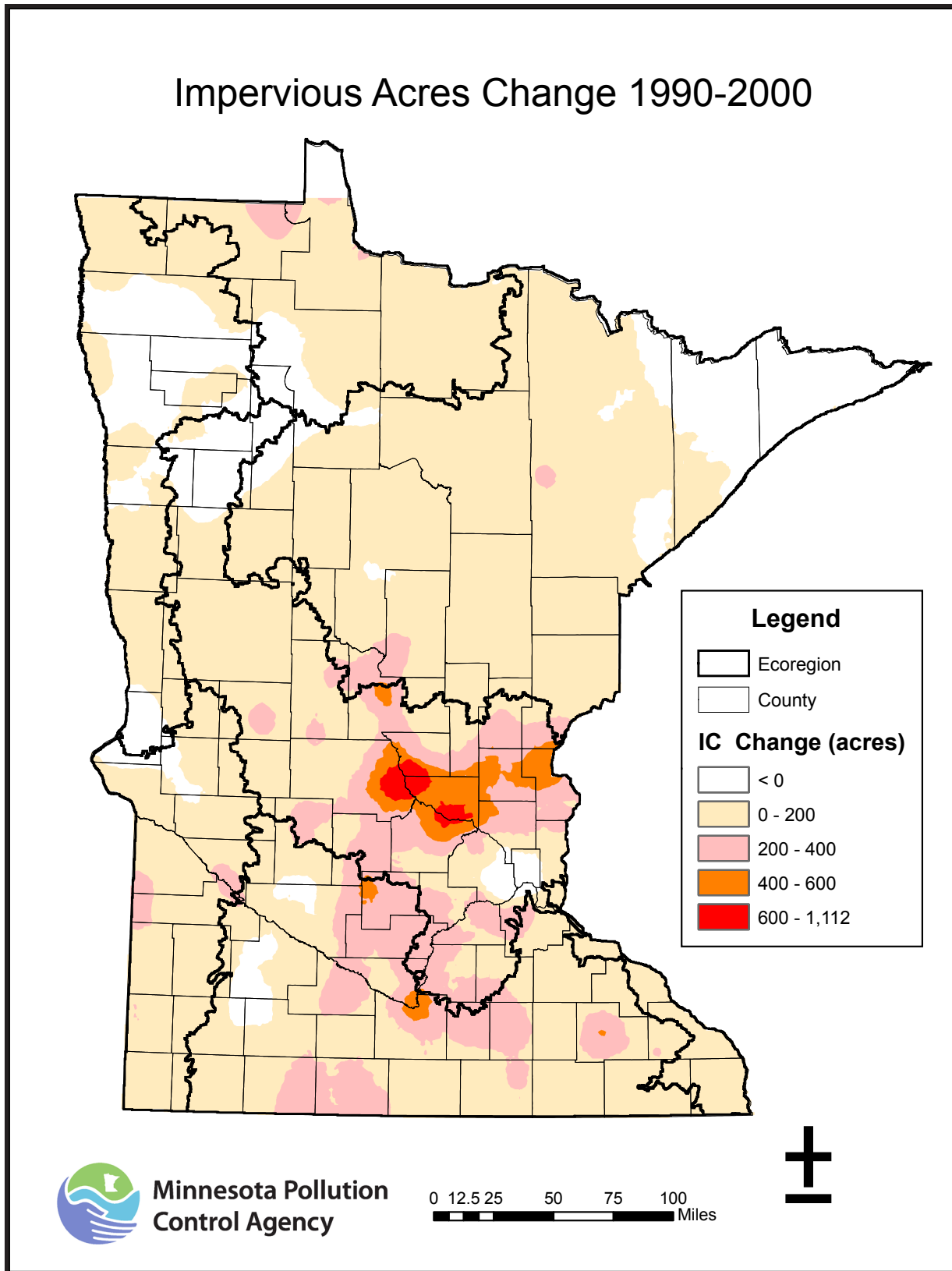


Figure L2. Impervious acres change 1990–2000. Credit: Bruce Wilson and Mike Walerak, MPCA.

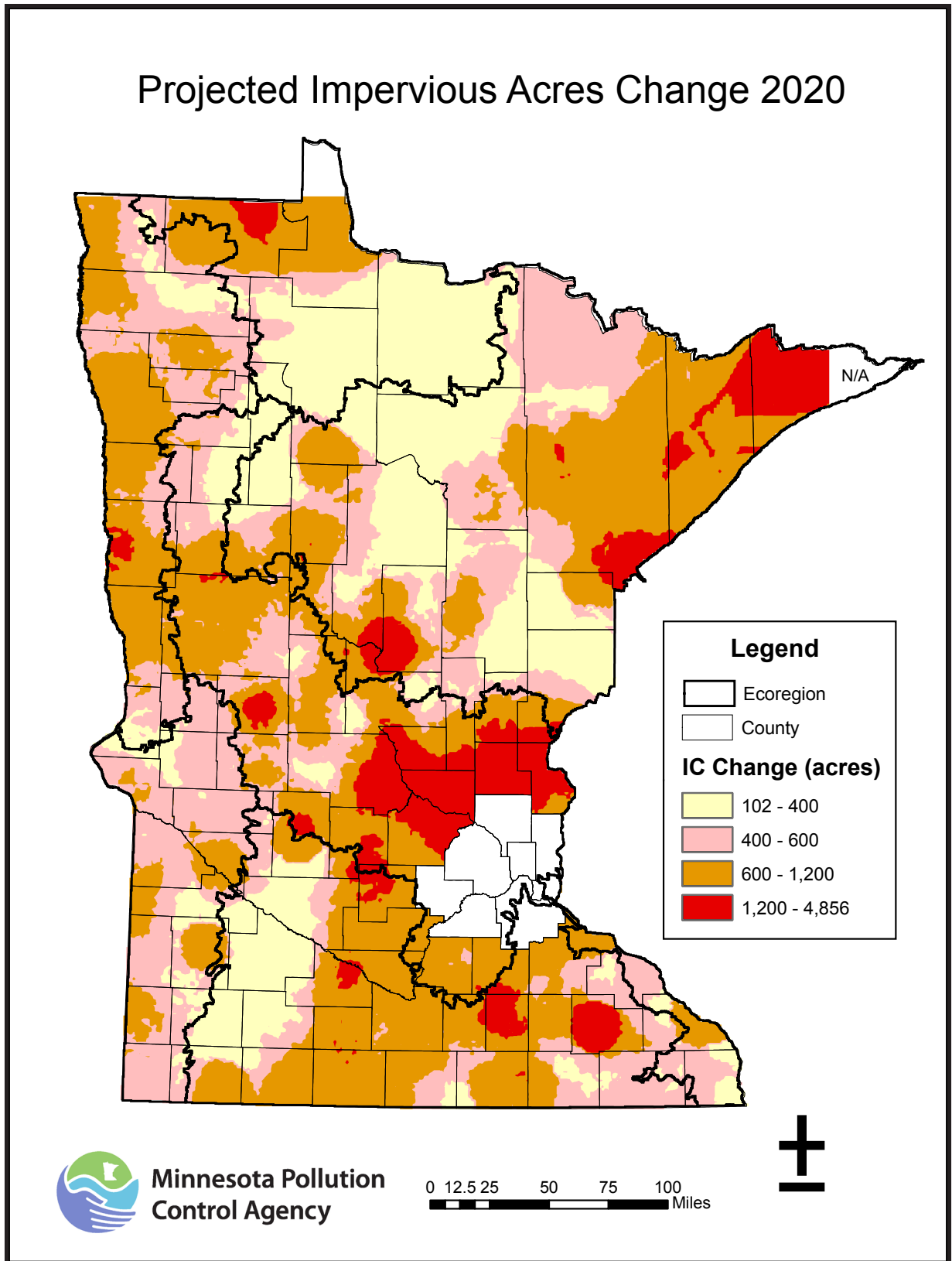


Figure L3. Projected impervious acres change 2020. Credit: Bruce Wilson and Mike Walerak, MPCA.

Drivers of Change for Community Land Use

Development of land resources directly results in many of the most significant drivers of change causing loss and degradation of Minnesota's resources, including the following.

Consumptive Use, Habitat Loss, and Invasive Species

Development leads to the irreversible loss of prime agricultural land, high-quality forests and prairies, pristine shorelines, and open space. In so doing, it depletes wildlife and aquatic habitat and results in habitat fragmentation. In addition, removal of land cover leaves the area more susceptible to invasive species.

Hydrologic Modification and Solids, Nutrient, and Contaminant Loading

Grading and construction of roads and buildings modifies hydrology by interrupting natural watershed drainage. Removal of land cover and increased impervious surface area change the volume, rate, timing, and duration of storm-water runoff. They also increase total runoff of sediment, phosphorus, and contaminants to surface waters.

Air Contaminants and Climate Change

Increased vehicle miles traveled (VMT) and commute times are associated with increased emissions of carbon dioxide (CO₂), a greenhouse gas (GHG) linked to climate change. They also create more carbon monoxide (CO), nitrogen oxides (NO_x), tropospheric ozone, and other transportation-related air pollutants.

Clearly, the fundamental step necessary to alter these trends is to change how we develop and use land across the state. To some extent, all development affects natural resources. However, different patterns of development have different effects. Therefore, supporting conservation-based planning at all levels

of government in Minnesota communities underlies all of the land use recommendations. Conservation-based planning puts the identification and conservation of priority natural resources at the center of the land use planning process.

Community Land Use Recommendations

Land Use Recommendation 1: Fund and implement a state land use, development, and investment guide



Description of recommended action. The state spends billions of dollars each year on infrastructure, local government and business assistance, and regulation in order to safeguard the environment, help business and communities thrive, and improve the quality of life in Minnesota. However, there is no system or guide in place to provide an overview of how these funds are spent across agencies, to track how these dollars come together on the land and in communities, and to determine whether investments in one sector put those in another at risk.

In addition, while most land use decisions are made at the local level, state-level vision and leadership are needed on many natural resource issues. The state needs to clearly define its interests and use its resources to engage others in securing those interests for the long term. Therefore the preparation and implementation of a state land use, development, and investment guide should be funded. The guide would provide a way to define, quantify, and unify state goals and investment objectives across social, economic and environmental sectors. It would offer the opportunity to reconcile conflicting goals and preserve Minnesota's natural resources. This is more important than ever, given the intense competition for land and resources and the chronic scarcity of state funds coupled with the uncertainties introduced by climate change.

The guide would provide a much-needed framework for aligning activities at multiple levels with state-wide natural resource goals. The guide would:

- Identify specific state goals, principles, and policies relating to climate change, land use, development, and investment
- Incorporate the priorities and recommendations of the SCPP
- Define the appropriate connections between transportation, land use, energy use and development, economic development, and natural resources and environmental protection, preservation, and restoration
- Describe how state investments will be coordinated, integrated, and staged to meet the state's goals and respect the connections
- Establish priorities for the allocation of scarce funds and resources
- Ensure that state dollars are not spent in a way that adversely affects state goals
- Identify legislative initiatives key to implementation.

Development of the guide should engage Minnesotans in a continuing dialogue about the future. The guide would be renewed every five years based on updated information on resource management, purchase, research, and data collection and management; the routine evaluation of its implementation; and assessment of its effectiveness. The guide would also be widely distributed to counties, cities, townships, the Metropolitan Council and regional development agencies. Much of the information contained in the guide would be advisory to these regional and local governments, but consistency with its core goals, policies, and principles should be mandatory whenever state funds are involved.

Description of impact on natural resources. Damage to natural resources generally results from efforts to meet other needs, whether for energy, transportation, health care, housing, recreation, or waste management. By making sure that state monies are spent in a way that aligns with state natural resource goals,

natural resource interests will get in on the “ground floor” as the solutions to other community needs are contemplated. This has significant implications for protection of high quality natural areas, priority agricultural lands, water quality, outdoor recreation, and the many other aspects of natural resources the SCPP is designed to address.

Relationship to existing programs, laws, regulations. The state has adopted many policies that independently direct consideration of natural resources in decision making. This recommendation would bring those disparate pieces together.

Time frame. With dedicated effort, the first guide could be completed within one year and applied during the following capital budget year.

Geographical coverage. Statewide

Barriers. Preparation and implementation of the guide will be challenging because it requires changing how problems are approached and actions are interpreted. In the context of state government, this means expecting people and programs with limited resources to recognize that broader approaches to different kinds of issues can sometimes achieve far better outcomes for the communities and overall state interests they serve.

State leadership must value, support, and take responsibility for ensuring implementation of guide goals, principles, and recommendations. Challenges will include possible resistance to granting the programmatic discretion necessary to serve broader community goals.

Land Use Recommendation 2: Support local and regional conservation-based community planning



Description of recommended action. The objective of this recommendation is to promote land use planning that advances the permanent protection and restoration of Minnesota’s natural resources, important agricultural areas, and open space by supporting conservation-based planning in local and regional communities. The recommendation contains four elements:

- Demonstration (pilot projects)
- Incentives
- Tools and technical assistance
- Investment in base data

This strategy builds on the broader vision, goals, and criteria established under land use recommendation 1—the state land use, development, and investment guide—and refines it for local and regional use. Local governments and conservation organizations can be key agents in implementing the SCPP and local stewardship significantly expands the state’s capacity to protect and restore natural areas. Supporting local and regional communities in conservation-based planning will help communities establish long-term goals that are consistent with the state’s goals, and allow communities to implement those goals as development occurs.

Conservation-based planning entails proactive and detailed planning for future land use that places preservation of priority natural resources (including priority agricultural lands) at the center of the land use planning process. Conservation-based planning is conducted early in the development or redevelopment process and the community looks at a wide area well beyond where development is currently taking place, considering economic activities dependent on natural resources such as agriculture, forestry and tourism. This allows for coordinated planning of the “green” and “gray” infrastructure such that development of transportation (transit, roadway, and

bike/pedestrian) networks can occur while ensuring preservation of natural resources, priority agricultural lands, green space, and planned rural areas.

In the optimal conservation-based planning process, the community identifies its natural resource assets and liabilities through extensive natural resource inventories and assessments using MLCCS cover data or an equivalent mapping system. It develops potential mitigation strategies and uses modeling such as scenario planning and build-out analysis to evaluate the environmental impacts of each. The community then creates a mixture of public policies and funding programs to enable natural resource protection, and links conservation and development so resources are conserved as development takes place. Because natural resources do not stop at political boundaries, as part of the process communities work collaboratively with adjacent counties, cities, towns, and agencies to advance local economic development, housing, social, and environmental objectives.

In order to support conservation-based planning in local and regional communities, four elements are needed: Demonstration, incentives, tools and technical assistance, and base data. The following subrecommendations describe each of these elements.

2A. Demonstrate conservation-based planning through pilot projects

Pilot projects that embody all the elements of good conservation-based planning, as outlined above, would help create an understanding among local and regional communities of the processes involved, identify barriers, and demonstrate benefits. The projects would also generate feedback on adapting strategies for optimal function and effect. Different approaches may be appropriate in different parts of the state, depending on the issues of concern to a particular community or region. Therefore, funding for three types of pilot projects is recommended.

Conservation-based planning in a variety of local communities: These pilot projects would take place in several representative communities from across the spectrum of community types—urban, suburban, rural—that could serve as models for many other communities.

Conservation-based planning along a rapidly developing transportation corridor (involving multiple communities): This process would involve multiple jurisdictions cooperating to develop a detailed area plan for the transportation corridor that would be incorporated into a regional transportation and land use plan guiding future development.

Conservation-based planning resulting in an AUAR-certified comprehensive plan: One pilot project should support a community in conservation-based planning that results in an Alternative Urban Area-wide Review (AUAR)-certified comprehensive plan. This can benefit communities because AUARs are an authorized alternative to traditional environmental impact statements (EISs) and so can streamline the environmental review process.

2B. Provide incentives to local governments and conservation organizations for conservation-based planning

Recent trends in decreasing federal and state natural area grant programs and decreases in general state aid to local governments have undermined local planning and stewardship capacity, even as growth pressures on natural resources have increased. Financial incentives are needed to engage local partners in planning and implementation that meets local and statewide conservation goals.

Provide financial assistance to communities to undertake conservation-based planning: A fund should be established to provide financial support to communities that have a demonstrated

commitment to conservation-based planning but that lack the resources and staff to undertake and complete the planning process. Most typically, this will be smaller, exurban communities that are in the early stages of development but that do not yet have the added financial resources that growth can make available to a community.

Provide financial assistance to communities to support implementation of conservation-based plans: A statewide grant program should be created that would provide funds to communities that have completed and adopted a conservation-based plan with the highest standards and have used all available tools for implementation, but that still need financial assistance to “close the gap” so implementation can be fully achieved. Implementation dollars would be available to local units of government (counties, cities, watershed districts, school districts) and nonprofit conservation organizations for implementation activities including acquisition; restoration; alteration of planning, zoning, codes, and other regulations; development review; and installation of conservation measures (e.g., rain gardens). The grants would reflect the state’s conservation priorities as identified in conservation-based plans, foster partnerships between local governments and nonprofit organizations with expertise in implementing aspects of the conservation-based plan, and build local capacity to conserve water quality, natural lands, and parks.

2C. Provide tools and technical assistance for conservation-based planning

To develop conservation-based plans, communities must have access to appropriate tools and technical assistance. These include:

Carbon calculator for communities: This recommendation is to develop a simple carbon calculator for communities (rather than for single structures) that would enable Minnesota communities

to readily understand the effects of their land use decisions on greenhouse gas emissions, test alternatives, and make better planning decisions.

Improve agricultural land preservation tools: Existing long-term agricultural land preservation tools are expensive or difficult to successfully implement, and other types of tools offer only short-term protection that cannot withstand strong conversion pressure. Programs and policies from other parts of the country are difficult to adapt to Minnesota's law and culture. To address this, a one-time, multiday congress would be held to bring together Minnesotans with national experts to explore ways Minnesota's agricultural land can be preserved for the long term. Congress topics would include farmland preservation techniques (e.g., purchase of development rights, transfer of development rights, zoning regulations) and agricultural economic development (e.g., development of markets for local food, organics, etc.). At the end of the congress, through a facilitated process, participants would develop reform concepts for future consideration.

Develop and deliver outreach materials: Communities need materials to help them educate themselves, the public, and industry on conservation-based planning processes, tools, and outcomes. Outreach materials should include findings from pilot projects (Land use recommendation 2A); GIS mapping and analysis tools; best practices on building community support, funding identification, and program design; implementation issues, such as land appraisals, easements, and easement compliance; and federal Farm and Ranchland Protection Program (FRPP) requirements.

The state should support work currently underway to build and maintain a comprehensive Web site containing a wide array of best practices. All of the pilot projects should be posted here, along with a detailed description of successful innova-

tions and lessons learned. This resource center should be linked to the pending National Urban Land Institute (ULI) GreenResource Center, and the Minnesota ULI Regional Council of Mayor's Sustainability Committee Web site. All of these best practices and resources should be broadly promoted and distributed through the Association of Counties, the League of Minnesota Cities, the Association of Townships, and others.

Establish a Minnesota natural resources and development partnership: This would be a collaborative, multidisciplinary, intergovernmental partnership that would coordinate support and technical assistance across sectors to help Minnesota communities prepare and implement conservation-based plans. It would address several key challenges, including lack of local capacity, particularly in small communities; fragmented state assistance and investment; federal, state, and local actions that are not always complementary; and assistance that is difficult for communities to access. The partnership would encourage and empower state agencies to combine resources and provide an integrated approach to delivering state assistance. The partnership would operate under the direction of the proposed state land use, development, and investment guide (land use recommendation 1), and ensure that those statewide goals and local conservation-based plans come together for communities "on the ground."

Invest in building state assistance capabilities: In order for state agencies to fulfill their role in the natural resources and development partnership, they need to be more user-friendly community partners that strategically coordinate and integrate the expertise, information, and assistance they offer to better serve local goals and achieve results. This will require additional support for state agencies, both to better connect staff expertise to local communities (through, for example, technical assistance, training workshops, and mentoring opportunities) and to support greater

coordination among the community outreach staff across state agencies. This will begin to reduce the fractured system in place to conserve our state's resources, enable pooling or leveraging of state grant funds, and serve as a model on how to work in an interdisciplinary and interagency fashion.

2D. Invest in generating base data and information necessary to support conservation-based planning

Accurate information about the type and quality of natural resources is essential for making sound planning decisions. Improved planning that uses land cover and other types of natural resources information can identify areas in need of restoration, areas for protection, areas for landscape connectivity, and areas more suitable to development that minimize or avoid environmental degradation and loss. Nearly all of these proposed land use recommendations require accurate, reliable, and standardized information about the type, location, and quality of existing resources as well as an understanding of general land cover type. However, this information is currently severely lacking in the majority of the state, particularly in critical areas.

Develop appropriate MLCCS data in areas vulnerable to near-term development or conversion of land cover: The MLCCS can provide detailed and accurate information that allows great precision and accuracy in conservation and planning. This information allows communities to develop green infrastructure plans that are based on solid data and site-specific conservation strategies. The Minnesota Land Cover Classification System (MLCCS) is particularly useful for planning because it provides a standardized platform for capturing land cover information and is in a format that can be analyzed flexibly, depending on the intended end use. Importantly, it provides broad linkages across multiple categories of recommendations, including water quality, habitat,

recreation, urban planning, and open space preservation. Completion of MLCCS data should be funded for select portions of the state, with a priority emphasis on areas vulnerable to near-term land-cover conversion, including growth corridors and areas at high risk for natural resource extraction (timber harvest or mining) where permanent or irretrievable land cover change is likely.

Update statewide land-cover databases and remote sensing capabilities: Conservation-based planning and resource management rely upon land cover and water body characterizations that are up to date and reflect changes from past inventories. Over the next few decades, there will be substantial challenges to preserve our land and water resources in the face of climate change, increasing populations, energy demands, fires, drought, floods, and infestations. Because land and water characteristics can change quickly, statewide land cover and lake quality data should be updated every five years. In order to do this in a cost-effective manner, given Minnesota's geographic area and diversity of land and water forms, continued and expanded use of state-of-the-art remote-sensing techniques will be required. The state should acquire aerial remote-sensing capabilities to obtain near-real-time updating of critical land-cover/land use information for protection and rehabilitation of watersheds.

Description of impact on natural resources. Through the preparation and implementation of strong, conservation-based community plans, we can move toward a future with more compact, efficiently developed communities and supporting transportation networks along with strong, permanent systems of conserved open space (including large blocks of protected agricultural land), with minimal conflicts resulting from incompatible adjacent land uses. With creative, multijurisdictional planning efforts, permanently conserved natural resource systems can be linked into larger contiguous corridors of conserved

natural systems. In addition, with consideration of alternative build-out scenarios and environmental assessment and analysis in planning, environmental impacts can be positively and proactively avoided, minimized, and mitigated.

All of this means less habitat destruction, degradation, and fragmentation through conversion of natural areas and agricultural land into developed areas; less hydrologic modification from impervious surface area and road construction; lower air emissions coming from reduced vehicle miles traveled; and less solids, nutrient, and contaminant loading into waters. In other words, conservation-based planning will improve or reduce degradation of natural resources, including air, land, wildlife, water, fish, and recreation resources.

Relationship to existing programs, laws, regulations.

The overall concept of conservation-based planning relates directly to all land use statutes at all levels of government. It also builds on regional planning efforts through the Metropolitan Council and other regional development commissions.

Time frame. As soon as funding is available, all of these recommendations could be started.

Geographical coverage. The recommendations described above have statewide application and coverage. Even when pilot projects are carried out in specific areas, they serve as demonstrations with transferability to communities throughout the state.

Challenges. In several of the recommendations the main challenge would be determining which agency is in the best position to provide administration for the effort. In the Twin Cities metropolitan area, watershed districts, with their regulatory powers and access to financial resources, would often be well positioned to take a leadership role.

Additional challenges include:

- Agency staff are few and lack incentive programs to help guide communities
- Agencies need to change their typical approaches to include working through influence with communities, because state agencies own and manage a very small percentage of Minnesota's urbanized landscape
- Communities vary tremendously in their capacities to plan and act with greater environmental responsibility

Land Use Recommendation 3: Ensure protection of water resources in urban areas by evaluating and improving current programs



Description of recommended action. Changes to surface water runoff due to new development and redevelopment have significant impacts on most of the major drivers of change of Minnesota's natural resources. The state of Minnesota has a set of powerful surface water regulatory programs that are largely directed at controlling land use change and development practices to improve and protect water quality. These programs are supported and driven by federal and state statutes and rules, and include:

- Impaired waters and Total Maximum Daily Loads (TMDLs)
- National Pollutant Discharge Elimination System (NPDES) storm-water permitting
 - Municipal separate storm sewer systems (MS4)
 - Construction sites
 - Industrial sites
- Nondegradation for all waters
- Shoreland management

Experience with these regulations over the past several years suggests that a set of tools, monitoring programs, and education efforts would make these regulatory programs significantly more effective. These items, included in this recommendation, com-

prise an integrated set of measures to augment and supplement existing programs to better meet water quality standards and protect existing high water quality.

Four subrecommendations include:

- Credit system for storm-water and LID BMPs
- “Simple” modeling protocols for TMDL compliance
- TMDL BMP implementation monitoring
- Water quality media campaign

Land use practices for new development and redevelopment can protect and improve water quality. With appropriate augmentation and support, the existing regulatory framework can provide a level playing field that will promote and mandate the implementation of these practices as urban land uses expand. These measures will also support water-quality improvement when redevelopment provides opportunities for correcting past practices. This integrated set of measures will:

- Provide analytic tools for regulated parties, such as cities and developers
- Produce incentives to support development practices that protect and improve water quality
- Support better understanding of the effectiveness of a wide range of storm-water BMPs
- Provide a system of accountability for the various sectors and parties expected to implement BMPs to meet water-quality standards and improve water quality
- Establish educational programs that will reach the general public and raise the level of understanding and support for issues related to land use and regulations, and their relationship to water quality.

New development and redevelopment have, in the past, resulted in new impervious land cover and subsequent water-quality degradation. Maps included in this section indicate the extent of past and projected changes in impervious acres in Minnesota (Figures

L2 and L3). The measures included in this recommendation are intended to improve the effectiveness of the existing regulatory framework so that expected land use changes can occur and water quality can still be protected and improved.

3A. Credit system for storm-water and LID BMPs

For a limited number of storm-water BMPs, such as storm-water National Urban Runoff Program (NURP) ponds, a strong system of credits is integrated into the storm-water regulatory framework at multiple levels. This system of credits needs to be extended to a much wider range of BMPs, including low-impact development (LID) practices, conservation design, and nonstructural BMPs.

NURP developed a system that was very effective in supporting the design and installation of storm-water ponds. This system has four major components:

- Good scientific and research support
- Specific and detailed design guidelines enabling any engineer or designer to size and design an effective storm-water pond
- Quantification of the benefits of correct design and implementation—specific removal rates for phosphorus and total suspended solids
- Integration into all levels of storm-water regulations (state, city, watershed, etc.)

The result of this effort was the universal adoption and acceptance of storm-water ponds across all sectors. Designers working on projects could use the design guidelines to include storm-water ponds in their projects in order to meet permit and design standards from multiple reviewing and approving government entities.

This system needs to be extended to a wide range of relatively new BMPs. Many of the design standards are currently incorporated into the Minnesota Stormwater Manual. What is missing is a credit system for implementing the BMPs. A well-defined and strongly-supported credit system is needed to moti-

vate developers, builders, and local government units (LGUs) to include these practices in their projects.

This credit system must apply to multiple levels of the landscape. In a manner similar to NURP ponds, the credit system should apply to individual sites and construction projects. The credit system should also function at the regional and statewide levels. The Lake Pepin TMDL, for example, will probably call for a significant phosphorus reduction across the 60% of the lake's watershed in Minnesota. An effective credit system should function at this level to enable cities to determine whether their storm-water BMP programs are sufficient to meet the waste load allocation from the TMDL.

Steps to achieve this are:

- Develop a comprehensive list of BMPs (structural and nonstructural) currently in use by developers, builders, and LGUs
- Develop a comprehensive list of additional desirable BMPs
- Perform an extensive literature review to collect information on total load reduction, including pollutant removal rates and volume reduction.
- Based on the information from the literature review, develop a credit system for each BMP system; include guidelines on design standards with variation depending on the type of design and construction used
- Develop a system to address overlap and redundancy among BMP systems and instructions on how to address situations where multiple BMPs are applied to the same land area
- Prepare a report on the level of research and support for deriving the credit for each type of BMP system, identify and list strengths and weaknesses, develop a strategic framework to address BMP systems for which research support should be strengthened
- Incorporate the BMP credit system into the Minnesota Stormwater Manual and NPDES storm-water regulatory programs

3B. Simple modeling protocols for TMDL compliance

TMDL studies produce waste-load allocations and load allocations for pollutants. These allocations result in a responsibility for implementation of restoration measures by cities, other LGUs, and other landowners. In the case of municipal wastewater treatment plants and cities covered under the NPDES MS4 storm-water program, these responsibilities take the form of permit requirements.

Cities need a relatively simple storm-water modeling system to estimate current loading for a range of pollutants and changes to loading if various BMP systems are implemented on portions of the land in their jurisdiction. This type of modeling system would enable them to gauge their current loading compared to the allocation set in a TMDL. It would also enable them to design an appropriate mix of new BMPs that would constitute the most cost-effective approach to meet the TMDL load allocation in the future.

This simple modeling system would consist of a load estimating model based on land use and loading rates combined with a total load reduction model based on load removal rates and volume reduction rates appropriate for a wide range of BMP systems. This simple model could be used by all cities and other landowners with relatively low technical knowledge and manageable input requirements.

Steps to achieve this are:

- Review the current simple model used for non-degradation analysis by MS4 cities, and determine sufficiency for this purpose
- Integrate this project with the credit system for storm-water and LID BMPs, using the estimated total load reductions as the basis for the total load reduction model component of this system
- Develop an integrated loading rate and total load reduction model for use by cities and other landowners

- Prepare guidance documents and user instructions
- Integrate this model into protocols for TMDL studies and implementation plans
- Develop and implement outreach and training to support the wide usage of this model

3C. TMDL BMP implementation monitoring

Draft and implement a program of detailed BMP monitoring in selected representative watersheds with TMDL studies and implementation plans. In addition to monitoring the water body itself, this program would involve monitoring throughout the watershed to determine the effectiveness of BMP systems implemented by various entities and types of entities (agriculture, silviculture, cities, storm-water, wastewater, etc). It would also involve detailed in-stream or in-lake monitoring to better understand processes in the water bodies themselves, as well as contributions from the landscape and municipal infrastructure.

This monitoring program may include some BMP implementation monitoring – simply counting and documenting the extent of the implementation of BMP systems across the landscape. The main focus, though, will be water-quality monitoring to directly measure the impact and effectiveness of BMPs by measuring water-quality parameters at discharge points and in water bodies near or adjacent to the BMP systems.

This scale of monitoring would provide an important accountability framework for all parties involved in implementing BMPs and meeting water-quality standards (cities, watershed organizations, agriculture, etc.). This type of monitoring program has also been referred to as “sentinel watershed” or “representative watershed” monitoring.

Steps to achieve this are:

- Prepare a program workplan (goals, techniques, equipment, protocols, budget, entities and personnel to be involved, stakeholder group, technical advisory committee, etc.)
- Integrate with appropriate state agencies and entities (MPCA, DNR, Environmental Quality Board [EQB], Clean Water Council, etc.)
- Integrate with the statewide science and research strategic framework
- Integrate with existing and proposed research projects (e.g., stream-bank stability, bacteria fingerprinting)
- Select representative watersheds
- Implement water-quality monitoring program
- Review data and prepare reports

The first one or two watersheds should be pilot projects. The selected watersheds should be small and the implementation BMPs to be monitored should be relatively simple with rapid results. These watersheds should be worked through as completely as possible with the goal of learning important lessons before proceeding to larger and more complex watersheds.

The equipment to perform this monitoring, if purchased using state funds, should be owned by the state. This will significantly expand the state’s monitoring capacity.

3D. Water quality media campaign

Further develop and expand the reach of Minnesota Water—Let’s Keep It Clean!, a storm-water pollution prevention campaign produced by a coalition of cities, nonprofits, agencies, watersheds, and others working to develop pollution prevention resources for the Twin Cities metropolitan area.

This campaign is designed to enhance public education and awareness of storm-water pollution prevention strategies by disseminating messages in mass

media and providing educational materials for educators and municipal staff through the www.cleanwatermn.org Web site.

By expanding to reach a statewide audience, the campaign can reduce stormwater pollution discharges to receiving waters through the dissemination of effective and innovative storm-water pollution prevention public education materials and messages across the state.

Effective storm-water programs can improve water quality only when there is an appropriate level of understanding among and support from the general public. A broad-based multimedia campaign is an essential element to achieving these results. There must be large, statewide constituent groups to support:

- State regulatory programs
- Statewide legislative initiatives (e.g., the Clean Water Legacy Act)
- Local actions (e.g., cities' MS4 permit compliance)
- Market-driven efforts (e.g., LID and conservation design developments)

The Minnesota Water—Let's Keep It Clean! campaign's existing program development model would serve as the primary template for this activity. Steps are:

- Prepare a program workplan (audience, goals, techniques, protocols, budget, entities and personnel to be involved, stakeholder groups, steering committee, etc.)
- Integrate with appropriate agencies and other entities (MPCA, DNR, EQB, Clean Water Council, Metro Watershed Partners, Minnesota Cities Stormwater Coalition, Minnesota Stormwater Steering Committee, etc.)
- Integrate with the statewide storm-water pollution prevention public education strategic framework
- Integrate with existing and proposed research on maximizing the effectiveness of public edu-

cation campaigns relating to water quality and storm-water pollution prevention

- Select public outreach materials, activities, and products
- Implement a storm-water pollution prevention education program
- Review program effectiveness and prepare reports

Relationship to existing programs, laws, regulations.

The elements of this recommendation are intended to augment and supplement existing regulatory programs to better meet water-quality standards and protect existing high water quality. This integrated set of measures is beyond the current technical capacity or regulatory responsibility of the MPCA, DNR, BWSR, and other state agencies with storm-water and water quality regulatory roles.

These elements are designed to provide incentive systems, analytic tools, effectiveness and accountability monitoring, and educational support to significantly and cost-efficiently increase the effectiveness of the existing storm-water and water-quality regulations.

Time frame. The credit system and the simple TMDL modeling protocols should be developed as soon as possible. Both projects could be completed within two years.

The TMDL BMP implementation monitoring and water quality media campaign should be started as soon as possible but will extend over a longer period. Both should be viewed as 5- to 10-year efforts. These elements should yield some short-term results, but most of the positive outcomes will be seen in the longer term.

Geographical coverage. The storm-water and water-quality regulations extend statewide. The benefits of the elements of this recommendation will be seen in all these regulatory programs and will effectively supplement the efforts of all parties throughout Minnesota working to comply with these regulatory programs.

These regulatory programs cover a large number of cities, townships, counties, watersheds, construction sites, and industrial facilities throughout Minnesota. Improving the effectiveness of these programs will have a dramatic impact on the landscape and water quality statewide.

Challenges. There are no major challenges implementing all the elements of this recommendation. The scientific research and technical literature needed to develop and support these elements exists currently.

The participation of a significant number of stakeholder groups would be needed for the development and implementation of these elements. These groups are currently participating in the Minnesota Stormwater Steering Committee, the Clean Water Council, and other organizations and initiatives.

Costs. Costs of meeting this recommendation are:

- Credit system for storm-water and LID BMPs—approximately \$100,000
- Simple modeling protocols for TMDL compliance—approximately \$100,000
- TMDL BMP implementation monitoring—\$500,000 to \$2 million (over time)
- Water quality media campaign—\$500,000 to \$2 million (over time)

Agricultural Land Use

Agricultural production is highly dependent on and also has a large impact on natural resources, especially soil, water, and climate. The increasing demand for food, feed, fiber, and now fuel is resulting in more pressure on these natural resources. Access to productive land for agricultural use is also under pressure, affected by nonagricultural land uses including urban development. Protection of both the natural resource base and access to productive lands for agriculture will require improved planning and management in this rapidly evolving economic and technological environment.

Minnesota's agriculture and agro-ecoregions vary considerably across the state. It is not possible to address the wide range of products, production practices, and natural resources of the whole state in a limited set of recommendations. Appropriate production practices are described already in publications of University of Minnesota Extension, the Minnesota Department of Agriculture (MDA), the USDA Natural Resources Conservation Service (NRCS), the MPCA, and others. The focus here is rather on a very few key natural resource indicator conditions and trends, and some strategies to address them.

Key Natural Resource Conditions and Trends for Agricultural Land Use

Impaired Waters

Many of Minnesota's rivers, streams, and lakes in agricultural regions are impaired by sediment and nutrients and don't meet water quality standards for designated uses (Figure L4 and Table L1). Many more water bodies have yet to be tested and evaluated, so the list is incomplete.

Approximately half of the area of the state and most of Minnesota's agricultural production is in the Mississippi River watershed, which includes the Minnesota River. Lake Pepin, a natural lake formed by a constriction of the Mississippi River, is impaired by excess nutrients and turbidity. Major segments of the Minnesota River are also impaired by turbidity. Currently, a large group of scientists and modelers is conducting a multiyear TMDL study of these impairments, including interaction with a large stakeholder advisory committee. The results so far provide the following information.

Stream-bank erosion is a major and increasing source of sediment delivered to Lake Pepin, primarily from the Minnesota River and its tributaries. Estimates from several different methods and researchers indicate that streambank and other near-channel sources account for well over half of the sediment coming from the Minnesota River. The increasing proportion from this source indicates an increase in peak and bankfull flows over time. This would indicate a need to reduce peak flows and bankfull durations if this source is to be reduced. The contribution from upland field and gully erosion is still significant and needs attention, especially on sloping land near streams (Figure L5). See also the sections on erosion in the energy recommendations introduction and the preliminary plan of the SCPP.

Climate Change

GHG emissions continue to increase and are insufficiently mitigated with current practices (Figure L6). The introduction to the energy recommendations section of this report addresses this issue more fully and the reader is referred to that section. Biofuel sources and production methods have large effects on soil and water, so they are addressed in the recommendations for agricultural lands as well as the energy and mercury recommendations.

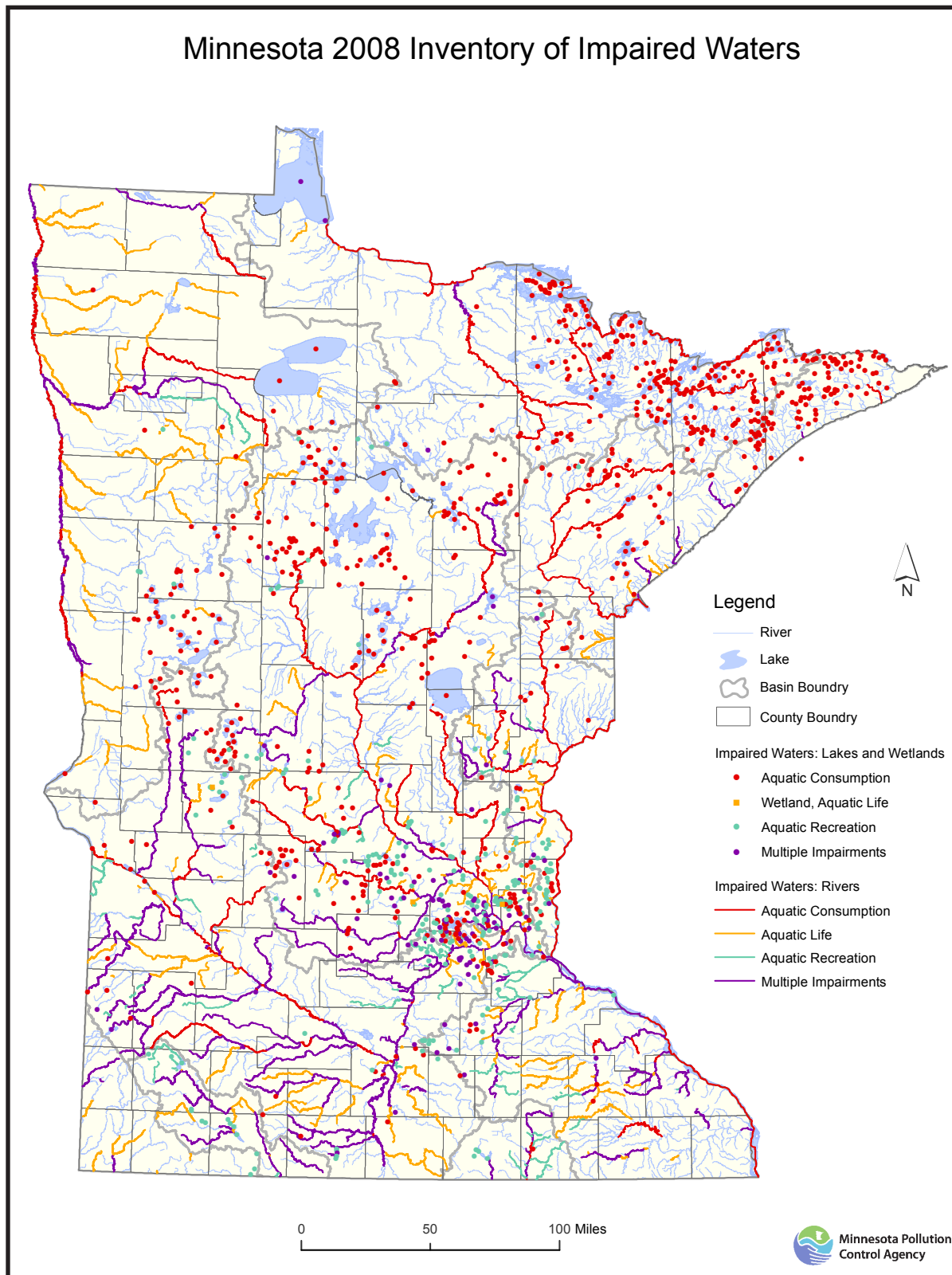


Figure L4. Minnesota inventory of impaired waters. Credit: Thomas Pearson, MPCA.

| Pollutant or stressor | Affected designated use |
|---|--------------------------------|
| Arsenic | Aquatic consumption |
| DDT | Aquatic consumption |
| Dieldrin | Aquatic consumption |
| Dioxin (including 2,3,7,8-TCDD) | Aquatic consumption |
| Mercury in fish tissue | Aquatic consumption |
| Mercury Water Column | Aquatic consumption |
| PCB in Fish Tissue | Aquatic consumption |
| PCB in Water Column | Aquatic consumption |
| Perfluorooctane Sulfonate (PFOS) in Fish Tissue | Aquatic consumption |
| Toxaphene | Aquatic consumption |
| Acetochlor | Aquatic life |
| Ammonia (Un-ionized) | Aquatic life |
| Aquatic macroinvertebrate bioassessments | Aquatic life |
| Aquatic Plant Bioassessments | Aquatic life |
| Chloride | Aquatic life |
| Fish bioassessments | Aquatic life |
| Lack of a coldwater assemblage | Aquatic life |
| Oxygen, Dissolved | Aquatic life |
| pH | Aquatic life |
| Temperature, water | Aquatic life |
| Turbidity | Aquatic life |
| Fecal Coliform | Aquatic recreation |
| Nutrient/Eutrophication Biological Indicators | Aquatic recreation |

Table L1. Pollutants grouped by affected designated use category. Credit: Thomas Pearson, MPCA.

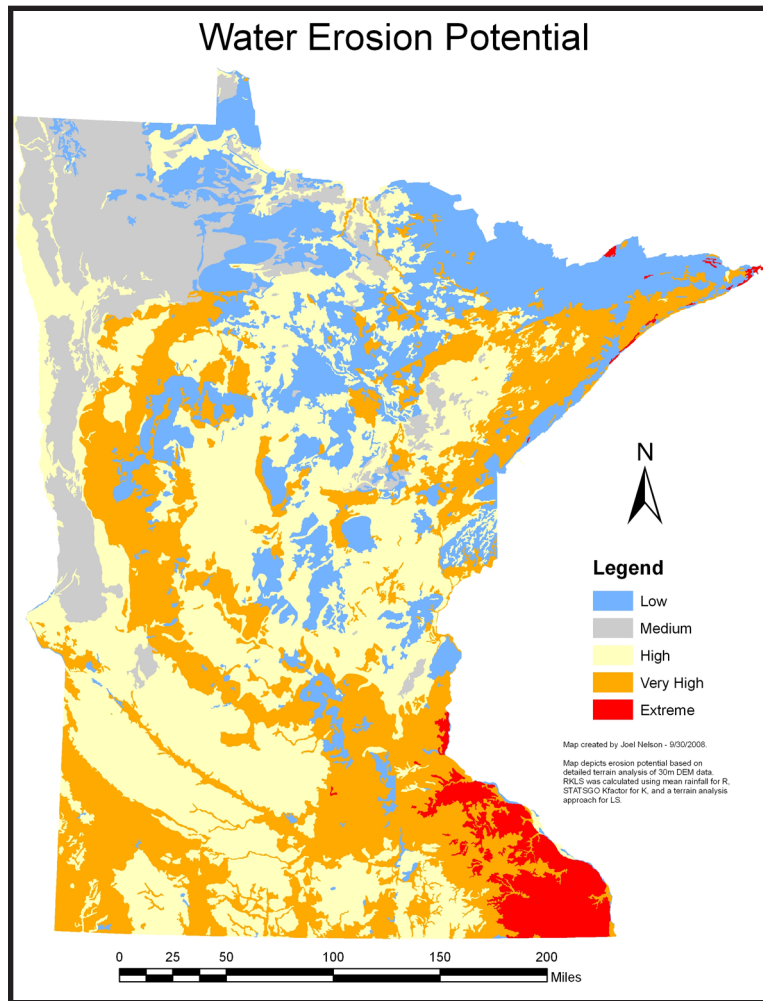


Figure L5. Potential soil erosion by water. Credit: David Mulla, UM.

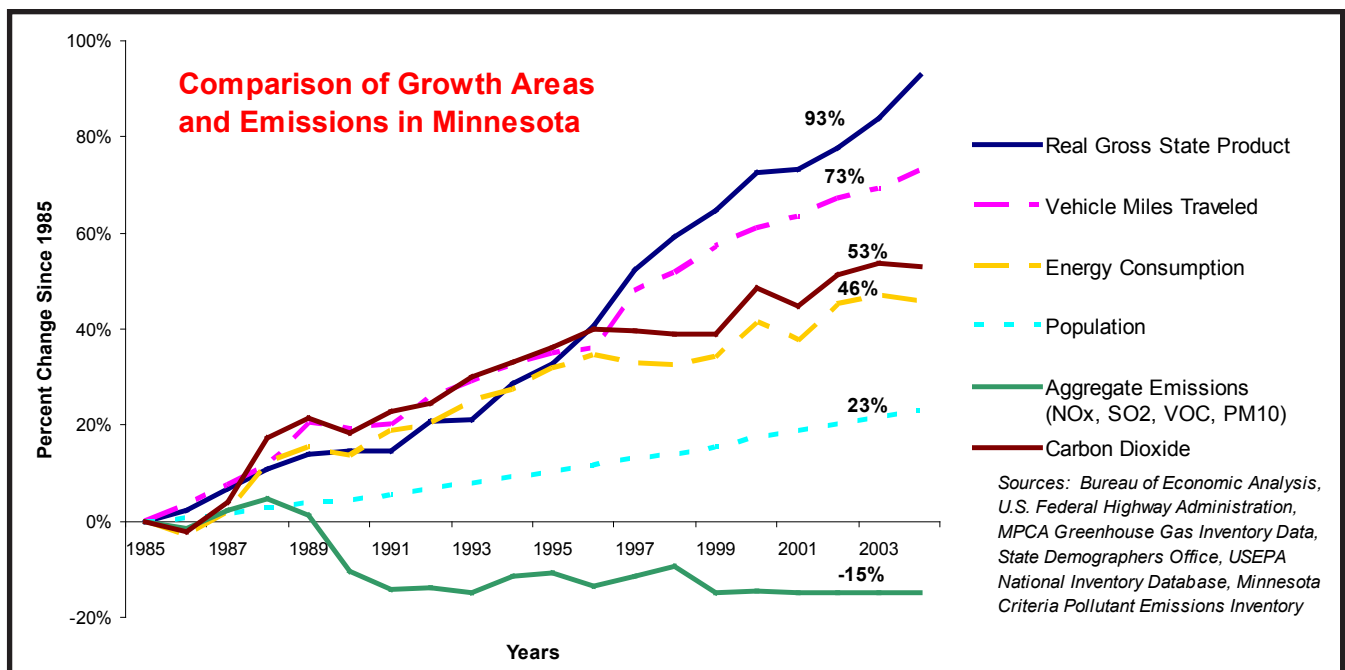


Figure L6. Comparison of economic and emission growth factors in Minnesota from 1985 to 2005. Credit: MPCA.

Loss of Agricultural Lands

Agricultural lands are being permanently lost to urban and residential development (Figure L7). This loss results from both the direct conversion of agricultural land to development and the fragmentation of agricultural areas by suburban and exurban sprawl, increasing conflicts with agriculture and reducing the availability of agricultural product and service providers in those areas.

Drivers of Change for Agricultural Land Use

The drivers of change affecting the condition of natural resources addressed by the agricultural recommendations include:

Land-Cover Changes on Agricultural Lands

Land in annual row crops has been steadily increasing while land in perennial crops, pasture, and nonrow annual crops has been decreasing (Figure L8). The lack of early-season ground cover in annual row crops decreases protection from soil erosion and nutrient loss and increases the volume of runoff due to lower early and late season transpiration. See Randall et al. (1997) for a comparison of drainage volume under various crops.

Altered Hydrology

Annual row-crop production is often accompanied by surface and subsurface drainage systems designed to quickly remove water from the field, enabling early-season field operations and improving plant growth in wet years. This altered hydrology affects peak stream flows and total volumes, and, in conjunction with recent increases in annual rainfall, can increase the potential for streambank erosion.

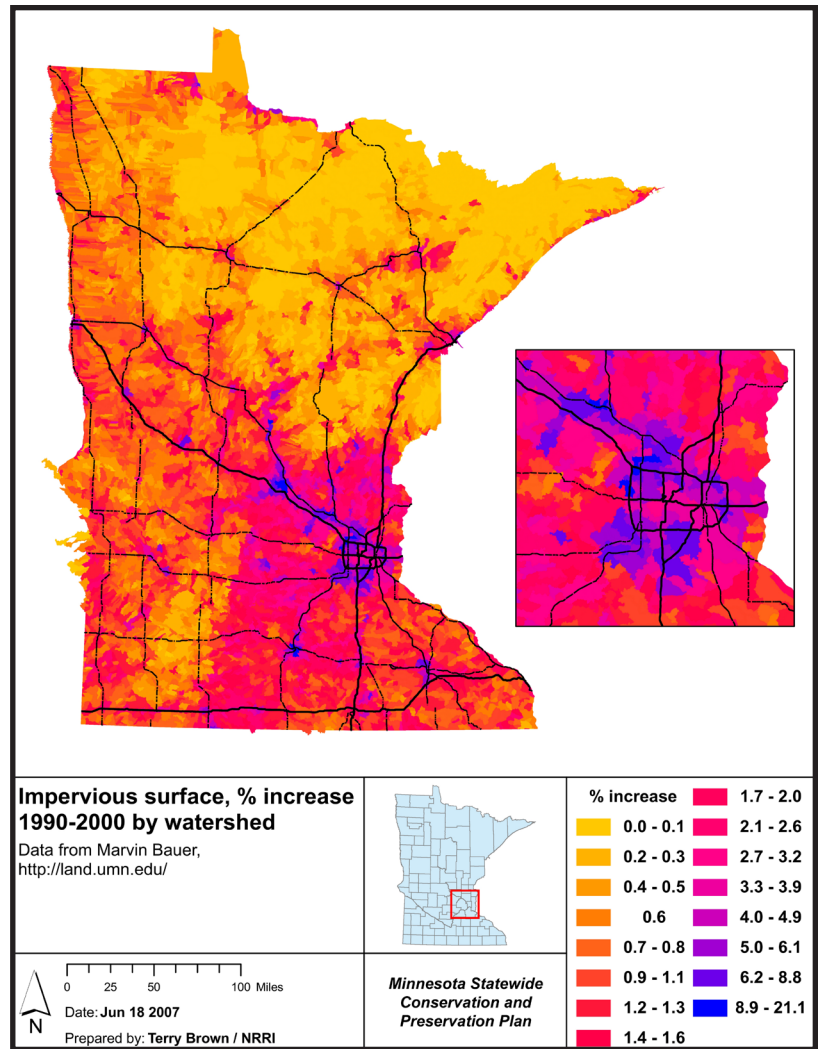


Figure L7. Impervious surface increase by watershed 1990–2000. Credit: Marvin Bauer, UM. Funded by LCCMR. Figure prepared by Terry Brown, NRRI.

Subsurface drainage systems also increase the delivery of nitrates to river systems.

Ethanol Mandates

Ethanol mandates are increasing the demand for corn, providing pressure for conversion of additional land to row-crop production, including land currently enrolled in the Conservation Reserve Program (CRP). See the introduction to the energy recommendations for graphs of expiring CRP (Figures E13, E14 and E15). Congressional agriculture committee leadership has indicated that there will be no attempt to keep CRP rental rates competitive with

the rapid increases in land rental rates for corn production.

Land Development

Rapid expansion of urban and residential land use is reducing the area available for agricultural production.

Agricultural Land Use Recommendations

Land Use Recommendation 4: As much as possible, transition renewable fuel feedstocks to perennial crops



Perennial species protect the soil from erosion throughout the year and reduce the volume of early-season water runoff (related to stream-bank erosion) because of a longer annual duration of evapotranspiration and increased infiltration. Additionally, the use of perennial cellulosic crops as feedstock for biofuels can significantly reduce life-cycle GHG emissions relative to grain-based ethanol production systems. Because an appropriate selection of perennials is less sensitive to risks such as temporary flooding and drought, and presents less risk of erosion and nutrient runoff, it can complement annual food and feed crops by occupying the more vulnerable land areas, stabilizing incomes and protecting the environment.

Conservation and protection of water quality and soils are strongly influenced by land cover. Perennial species protect the soil from erosion throughout the year and reduce the volume of water runoff (related to stream-bank erosion) because of a longer annual duration of evapotranspiration and increased infiltration. Additionally, the use of perennial crops as feedstock for biofuels can significantly reduce life-cycle GHG emissions relative to grain-based ethanol production systems.

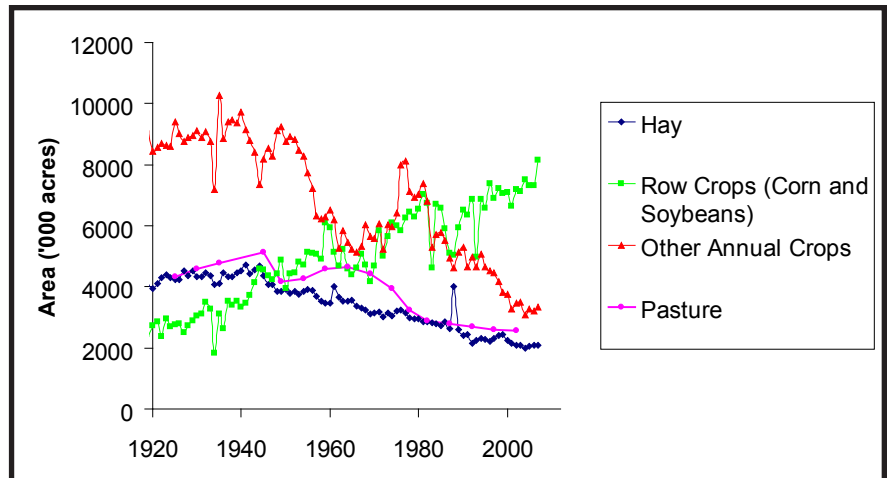


Figure L8. Acreages planted to hay, row crops, pasture and other annual crops. Credit: Laura Schmitt, UM.

This strategy directly addresses two of the key drivers of change: land use practices and energy production and use. Current trends in energy production and use are changing land use practices by increasing the land area in corn, replacing other annual crops and perennial cover. This strategy will facilitate a transition to use of perennial crops as feedstock for biofuels and other products, thereby improving protection of soil and water as well as affording a greater reduction in net GHG emissions.

4A. Invest in research on parameters that control successful perennial feedstocks

Description of recommended action. Invest in research to determine ecoregion and site-specific suitability and management of perennial species for use as feedstock for biofuels and other products. Minnesota agro-ecoregions (Figure L9) differ significantly in suitability for perennial species that can serve as feedstocks for biofuels and other products. Growing season length and temperature, precipitation, and soil characteristics are important determinants of species suitability. Research is necessary to help producers select site-specific perennial species for use as cellulosic feedstocks.

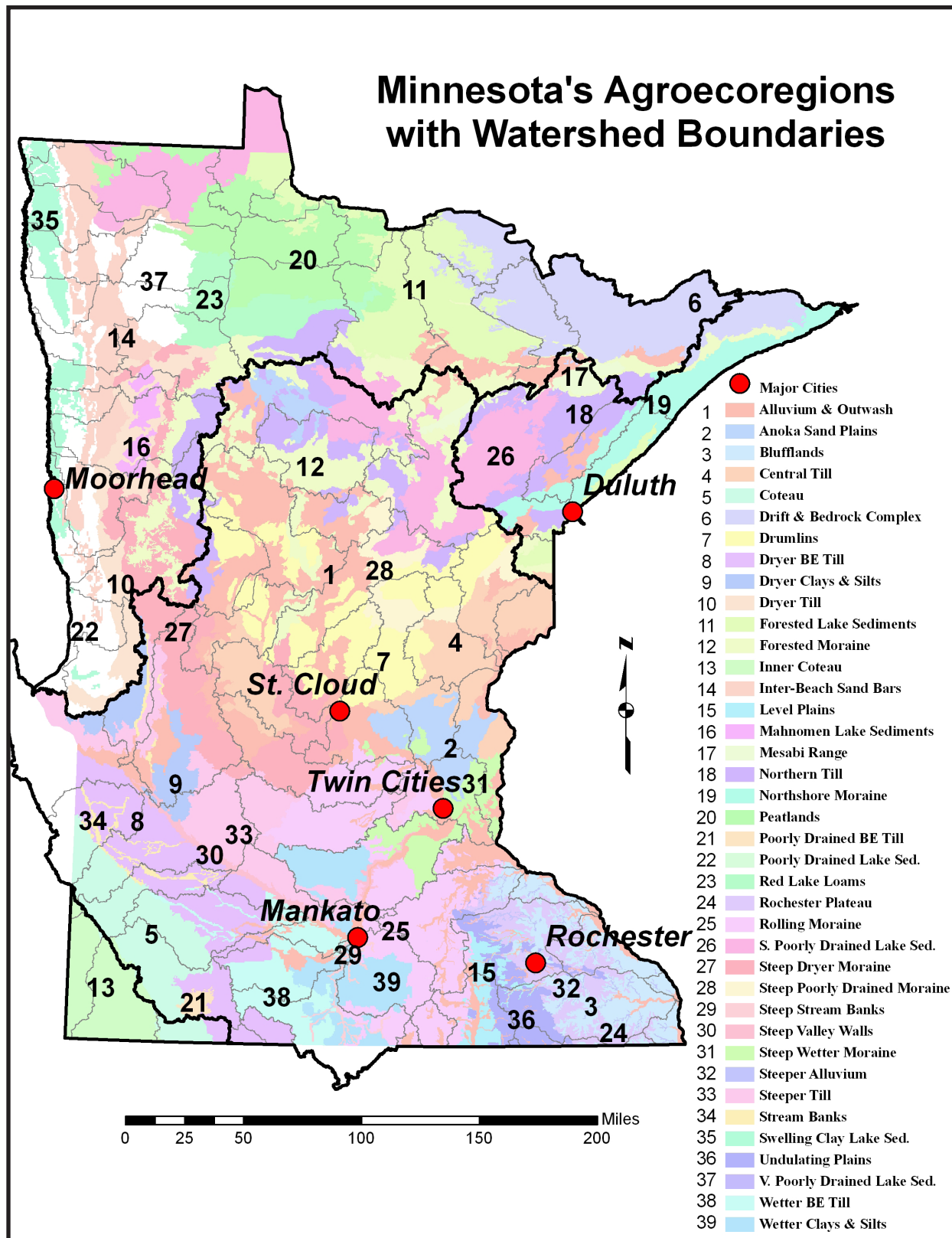


Figure L9. Minnesota agro-ecoregions differ significantly in suitability for perennial species that can serve as feedstocks for biofuels and other products. Growing season length and temperature, precipitation, and soil characteristics are important determinants of species suitability. Credit: David Mulla, UM.

Description of impact on natural resources. Research will:

- Optimize yields by matching appropriate species to agro-ecoregion and sites
- Optimize yields by developing management recommendations for individual species
- Minimize loss of nutrients and sediment through appropriate plant management

Relationship to existing programs, laws, regulations.

Existing research funding, both public and private, is focused primarily on annual crops traditionally used for food or feed, with some adaptive research, primarily in the private sector, on corn grain as an ethanol feedstock. There is very little research on site-specific suitability of perennial crops targeted for use as biofuel and bioproduct feedstock.

Time frame. This investment needs to begin now, and continue as a significant and ongoing component of agricultural and energy research. Initial investments should be higher because of the extensive species screening that will be necessary.

Geographical coverage. Agricultural areas statewide

Challenges. Availability of funds for research, along with as-yet undetermined processing qualities needed for feedstocks for biofuels and other products

Costs. An example of the cost of perennial crop research is the \$1.5 million annual budget of the USDA Agricultural Research Service (ARS) Plant Science Research Unit at the University of Minnesota (UM), which conducts forage research.

A second cost is the opportunity cost created by the competition of energy crops with food crops for research time and funds.

4B. Investigate policy changes on fuel feedstock transition

Description of recommended action. Investigate, analyze, and adopt policy that will gradually transition biofuel feedstocks produced for the Minnesota ethanol mandate to perennial crops. The transition should be matched to availability of processing technology and requirements for infrastructure development.

Description of impact on natural resources. This policy will:

- Reduce the volume of water runoff (surface and tile) because of a longer annual duration of evapotranspiration and increased infiltration (Randall et al. 1997)
- Reduce soil erosion
- Reduce net GHG emissions relative to current ethanol production systems (Farrell et al., 2006; Hill et al., 2006; Tilman et al., 2006)

Relationship to existing programs, laws, regulations.

Current Farm Bill commodity programs provide strong incentives for annual row-crop production, primarily corn, as feedstock for ethanol. Direct payments for corn in the 2002–07 Farm Bill are \$0.28/bushel. Price-dependent payments are not currently being paid since corn prices are high; however, they provide a floor-price guarantee not available to non-program crops.

As technology improves for use of perennial plants as feedstock for ethanol, incentives should change to encourage their use. The existing state mandate for ethanol blends in gasoline could be amended to gradually decrease the GHG equivalent of the ethanol produced to fulfill the mandate, which would strongly encourage a shift to perennial plant feedstock sources. California is implementing similar legislation aimed at reducing the life-cycle fossil carbon content of transportation fuels (<http://www.arb.ca.gov/fuels/lcfs/lcfs.htm>).

Time frame. Policy evaluation could begin immediately, with the objective of setting goals for the timing of transition to perennial feedstocks for ethanol.

Geographical coverage. Agricultural areas statewide

Challenges. Determination of the GHG equivalent of ethanol from various production systems will be needed, and will eventually include expected changes in soil organic carbon from production of various feedstocks. Initially this might be limited to a few classes (e.g., corn grain vs perennial crop biomass). In that case the ethanol source tracking is solely by type of ethanol production facility (grain or cellulosic).

Timing the transition policy to availability of appropriate technology and infrastructure development will require careful preparation.

Costs. Costs include:

- Determining the GHG equivalent of ethanol from various production systems
- Tracking ethanol sources (perennial crop cellulosic ethanol vs. other sources)
- Converting current ethanol infrastructure to cellulosic processing

Other costs will depend on the nature and efficiency of processing technology used and on the choice, productivity, and markets for biomass crops. This will affect economic returns to farmers and processors, and the ethanol price to users.

Land Use Recommendation 5: Reduce stream-bank erosion through reductions in peak flows



Reductions in peak and total flows by modification of drainage systems, and constructing and restoring wetlands and riparian areas in strategic locations, will reduce attendant stream-bank and near-channel erosion, a major source of sediment in the Minnesota River basin. While agricultural drainage is necessary, research-based modifications such as shallower tile placement can reduce downstream im-

pacts. With placement guided by more accurate digital elevation data, strategically located water storage would lessen the impact of both surface and subsurface drainage systems on stream channels and reduce nutrients in water. Some water storage areas could be occupied by biomass crops not sensitive to temporary flooding.

Research in development of the Lake Pepin and Minnesota River turbidity TMDLs has revealed that greater than 50% of the sediment coming from the Minnesota River is originating from near-channel sources, including stream-bank, gully, and bluff erosion. Furthermore, the contribution of these sources has increased substantially over the past century, indicating a gradual and major change in stream and river flows. This is due in part to an increase in annual precipitation since the 1930s, and also to the extensive artificial ditch-and-tile drainage network that continues to be installed, and that connects previously isolated landscapes to the river system. Research-based goals for peak-flow reductions will, if adopted and achieved, reduce the contributions of sediment from streambank erosion.

The principal drivers related to this recommendation are climate change and land use practices. Land use change began with European settlement, which resulted in extensive land drainage to enable agricultural production. A gradual shift away from mixed livestock and grain production systems, including perennial forage and pasture, to more cash-grain and grain-based livestock production has also contributed to changes in hydrologic regimes with a reduction in early- and late-season evapotranspiration.

5A. Invest in research that quantifies the relationship between artificial drainage and stream flows

Description of recommended action. Invest in research to determine the quantitative relationship among trends in precipitation, artificial drainage systems, and stream hydrology.

Determination of the quantitative relationship among trends in precipitation, artificial drainage systems, land cover, and stream hydrology would allow more precise targeting of mitigation strategies, since the relationships are complex and strategies will be site specific.

Description of impact on natural resources. The research investment would promote efficient selection and targeting of mitigation strategies.

Relationship to existing programs, laws, regulations. There is little research in Minnesota quantifying the relationship between artificial drainage and stream flows. The proportion of river-borne sediment from stream-bank and other near-channel sources has only recently been determined to be higher than previously estimated and rising over time. Studies to quantitatively partition the effects of changing precipitation, artificial drainage, and changes in land cover have not yet been initiated.

Time frame. These investments should begin immediately and continue until hydrologic peak-flow goals are attained.

Geographical coverage. Agricultural areas statewide

Challenges. Funds for research and modeling, elevation data acquisition, and monitoring data are limiting factors.

Costs. Financial cost of the research \$300,000 to \$500,000 for modeling, plus an undetermined amount for additional field research as needed

5B. Investigate policy changes for goals for peak flow reductions

Description of recommended action. Set research-based goals for peak-flow reductions through hydrologic detention, wetland and riparian zone restoration, and other measures.

Description of impact on natural resources. Research-based goals would provide quantitative requirements for the extent of mitigation measures.

Relationship to existing programs, laws, regulations. There are currently no explicit goals for peak flows or flow reductions. Existing programs in wetland restoration provide upland storage, but are not specifically targeted for maximum hydrologic effect.

Time frame. Goals for peak flow reductions should be prepared as part of the Lake Pepin and Minnesota River TMDL implementation plans, with other river systems to follow. Timing depends on availability of results of research determining the quantitative relationship among trends in precipitation, artificial drainage systems, and stream hydrology.

Geographical coverage. Agricultural and urban areas statewide

Challenges. Determination of necessary and achievable reductions in peak flows will require funding for modeling and research.

Costs.

- Financial costs for modeling
- Personnel costs for expert and stakeholder participation in goal setting

5C. Invest in targeted water detention

Description of recommended action. Invest in strategically targeted programs for reduction of peak flows through increased water detention in agricultural drainage systems, including wetland construction and restoration, in-ditch storage, and conservation drainage.

Targeted drainage water detention will reduce peak flows and attendant stream-bank erosion. It will also reduce sediment and nutrient contributions from uplands through sediment deposition and denitrification. Hydrologic detention measures should

complement programs and policies to reduce flows through more perennial crops and buffers.

Description of impact on natural resources. Targeted mitigation programs will:

- Reduce peak flows and attendant stream-bank erosion
- Reduce sediment and phosphorus contributions from uplands through sediment deposition
- Increase denitrification of drainage water

Relationship to existing programs, laws, regulations. Existing wetland restoration programs are not targeted specifically at modifying drainage systems to reduce peak flows. Programs must be coupled with peak flow reduction targets to make them effective for this objective.

Time frame. These investments should begin immediately and continue until hydrologic peak flow reduction goals are attained.

Geographical coverage. Agricultural and urban areas statewide

Challenges. Funds for mitigation programs are limited.

Costs.

- Funds for structures, land, and practices for drainage water detention
- Funds for technical services to select sites and design/install structures and practices

5D. Investigate policy changes for peak flow reduction

Description of recommended action. Investigate, analyze, and adopt science-based policy that strengthens mitigation of peak flows from artificial drainage systems.

Description of impact on natural resources. Analyzing and adopting policy for mitigation of

peak flows will ensure a baseline of peak-flow mitigation for reduction of streambank erosion.

Relationship to existing programs, laws, regulations. There is currently no effective policy regarding mitigation of peak runoff flows originating in rural areas. Minnesota Statutes 103E governs “public drainage authorities,” defined as “the board or joint county drainage authority having jurisdiction over a drainage system or project.” The statute requires drainage authorities to “give proper consideration” to downstream effects in establishing or modifying a public drainage project, but establishes no standards for mitigation, and applies only to public systems in construction or modification.

Time frame. A deliberative process should begin to review existing data and policies that would result in policy for peak-flow reductions. Timing depends on availability of results of research quantifying the relationship among trends in precipitation, artificial drainage systems, and stream hydrology.

Geographical coverage. Agricultural and urban areas statewide

Challenges. Determination of how much peak-flow reduction should be achieved through regulatory adjustment and how much through purchase of easements for constructed wetlands and other storage will require research, negotiation, and funds.

Costs.

- Personnel costs for expert and stakeholder participation in policy analysis and selection
- Personnel costs for policy implementation

Land Use Recommendation 6: Reduce upland and gully erosion through soil conservation practices



Education, targeted incentives, and practice-flexible, outcome-based soil and water conservation plans where needed would reduce soil erosion from fields

and areas of concentrated flows. The result would be reduced sediment and phosphorus delivery to water and protection of soil productivity. Certified crop consultants already deliver conservation-related services (nutrient and pest management) and can provide other field-based services in support of soil conservation to augment services provided by the USDA, NRCS and Soil and Water Conservation Districts (SWCDs).

Soil erosion from sloping fields, especially those near unbuffered streams, is a significant source of sediment and associated phosphorus. Current federal Farm Bill and energy policies and incentives are increasing row-crop production (Figure L8), especially on the sloping soils of southeastern Minnesota, where a high proportion of land has been in pasture and perennial crops. The increased width of tillage, planting, and spraying implements makes maintenance of erosion-control structures such as terraces and grassed waterways more difficult and less likely. The increased prevalence of corn following corn for ethanol production increases the prevalence of intense tillage to reduce crop-residue effects on corn early growth and yields. The percentage of cropland operated by renters, many of them with short-term leases and cash rents, exceeds 40% (2002 Census of Agriculture), lessening the incentive for long-term soil stewardship. Reductions in upland and gully erosion will require stronger incentives and standards for soil conservation if the trends above continue.

The principal drivers of change related to this recommendation are land use practices and energy production and use, resulting in more intensive row-crop production with less incentive for soil protection.

6A. Invest in soil conservation practices

Description of recommended action. Invest in education and incentive programs, leveraging federal, state, and local resources when possible, that target landowners in critical sediment source areas.

Landscape areas differ in potential to deliver sediment and nutrients to water, based on proximity, slope, and other factors. Education and incentive programs that target high-contributing areas will achieve more mitigation per dollar invested than nontargeted programs (Figure L5).

Relationship to existing programs, laws, regulations.

The four largest programs related to water protection in rural landscapes are funded by the federal Farm Bill conservation title. They are the CRP, the continuous sign-up CRP (CCRP) for buffers, the Wetlands Reserve Program, and the Environmental Quality Incentives Program (EQIP) for practices on working lands. None of these is specifically targeted to mitigation of listed impaired waters; however, the CCRP for buffers is targeted to areas near streams statewide. In the near term, the area in CRP will significantly decrease due to CRP rental rates that are too low to compete with returns from crop production. EQIP is likely to remain steady but not expand in the new Farm Bill. The smaller Wetlands Reserve Program, based on permanent easements, is likely to not lose ground but not gain much in the current environment. The state has been able to leverage the CRP through the Conservation Reserve Enhancement Program (CREP), adding sign-up incentives and contract duration for buffer areas. The two past CREP sign-ups were able to target buffers to specific large river basins, but not to specific lands identified as sediment and nutrient source areas. Wetland restoration is also part of CREP, providing matching funding from the state Reinvest in Minnesota (RIM) program and ensuring permanent easements on those restored wetlands.

Description of impact on natural resources. Benefits of funding targeted upland sediment reduction education and incentive programs include reductions in sediment delivery to waters with improvement of water quality. Sediment reductions are obtained with more economic efficiency than nontargeted programs.

Time frame. Targeted programs should be initiated as soon as possible.

Geographical coverage. Results of critical-area analyses determine the geographical targeting of programs.

Challenges. Funding for outreach programs and incentive programs is limited. Also, targeting federal programs is not under state control.

Costs.

- Funds for education and incentive programs
- Technical assistance for conservation practice implementation
- Personnel costs for determination of sediment source areas and targeting of programs

6B. Investigate policy changes to reduce upland and gulley erosion

Description of recommended action. Investigate the feasibility of developing or amending policy, such as water quality rules, to phase in outcome-driven, practice-flexible soil and water conservation plans for all farms with potential to deliver sediment and nutrients to water bodies. The phase-in priority could begin with farms in watersheds with sediment and phosphorus-related impairments.

Description of impact on natural resources. This policy would:

- Reduce sediment and nutrients delivered to water bodies, improving water quality if policy is adopted
- Maintain the productivity of agricultural soils

Relationship to existing programs, laws, regulations. The only current policy addressing erosion and sediment from agricultural fields is the conservation compliance provision of the federal Farm Bill. That provision only addresses fields classified in the bill as Highly Erodible Land (HEL). The conservation compliance requirements set in the 1985 Farm

Bill were later relaxed, and were never designed to address sediment delivery in an impaired waters framework. Many fields not in the HEL category deliver sediment via concentrated flow, and are not addressed by the conservation compliance provision. Current yield-based federal commodity subsidies, as well as ethanol mandates and subsidies, are strong incentives for maximizing both area and yield of annual row crops with no constraint on sediment and nutrient delivery to waters, except for the HEL provisions listed above. While flexibility is needed in how erosion will be controlled, standards are needed for reducing sediment delivery. A soil and water conservation plan allows the necessary flexibility in management while ensuring that goals for sediment and nutrient delivery reductions are met. One possible policy framework to consider would be state water-quality rules. (Note: The soil and water conservation plan referenced here is more limited in scope than the NRCS Conservation Plan, which addresses additional resources.)

Time frame. Policy alternatives should be investigated with recommendations available by 2011.

Geographical coverage. Statewide

Challenges. Water-quality rules are administered by MPCA, while expertise on conservation planning resides with the SWCDs and NRCS. Precedents exist for cross-agency program administration: for example, feedlot rules are administered by a combination of MPCA, county feedlot officer, and DNR staff. The rules would need to be carefully written to achieve the necessary reductions in soil erosion and sediment delivery to waters without excessive paperwork and intrusion. The focus would need to be guided by soil and nutrient loss predictive tools like RUSLE2 and the Phosphorus Index, as well as locating and treating concentrated flows. Technical assistance could be provided by the producer's current crop consultant.

One challenge would be to define the erosion and sediment loss standards for designing the level of treatment necessary.

Costs.

- Personnel costs for policy analysis
- Technical assistance for preparation of soil and water conservation plans if policy is adopted
- Cost of erosion control structures where necessary if policy is adopted

Land Use Recommendation 7: Enable improved design and targeting of conservation through improved and timely data collection and distribution



Determination of sediment source areas, targeting of conservation practices, determination of effectiveness of practices, and installation of conservation structures all require adequate resource data. These include high-resolution digital elevation data, land cover, crop residue coverage, and conservation practice effectiveness monitoring.

Planning, targeting, and implementation of conservation practices to protect soil and water require adequate and current data. Few data are currently available, and the lack thereof significantly impedes selection, siting, and installation of conservation practices to mitigate impaired waters.

The principal driver of change related to this recommendation is land use practices. The data specified below assist in tracking land use practices and predicting their effects on natural resources.

7A. Invest in data collection

Description of recommended action. Invest in the following basic information to support soil and water protection:

- Statewide high-resolution digital elevation data (LIDAR) and associated high-resolution watershed delineation

- Statewide updated land-cover data
- Maps of the artificial drainage network
- A long-term program monitoring the effectiveness of BMPs on critical source areas
- An annual crop residue survey (following planting) of sloping lands near streams
- A periodic detailed survey of benchmark sampling sites to determine trends in soil erosion, as was carried out previously by the NRCS for the National Resources Inventory
- Periodic remote sensing by aircraft and/or satellite for land cover and other attributes

Description of impact on natural resources. This recommendation would provide:

- Information that enables identification, quantification, and characterization of sediment source areas, resulting in more efficient targeting of mitigation investments
- Information that enables prediction of hydrologic responses and selection of cost-effective mitigation investments
- Information on effectiveness of mitigation strategies that improves design and selection

Relationship to existing programs, laws, regulations. The above-listed data are not currently available.

Time frame. The above data should be acquired as soon as possible.

Geographical coverage. Statewide

Challenges. Funds to obtain and maintain the data

Costs. Funds would be needed for:

- Statewide LIDAR: \$7 million, reducible by negotiation with counties that have already acquired the data
- Statewide updated land-cover data (see land use recommendation 2)
- Monitoring of BMP effectiveness: \$600,000 to \$800,000 annually from multiple sources
- An annual crop residue survey of sloping lands near streams: \$180,000 annually

- A periodic detailed survey of benchmark sampling sites to determine trends in soil erosion, as was carried out previously by the NRCS for the National Resources Inventory
- Periodic remote sensing by aircraft and/or satellite for land cover and other attributes (see land use recommendation 2)

Forestry Land Use

The forests that cover nearly a third of Minnesota's land area play an important role in the ecological, economic, and social fabric of the state. The conifer forests of the northeastern part of the state and the hardwood forests of the central and southeastern parts provide substantial ecosystem services, including providing wildlife habitat, intercepting precipitation, filtering out water pollution, and sequestering carbon. These working forests also support a large forest-products industry and provide opportunities for outdoor recreation.

These recommendations provide strategies to improve the long-term health, productivity, and sustainability of Minnesota's forest resources in the face of key drivers of change, including forest parcelization, climate change, invasive species, and development pressures. These strategies build upon the important work of the Minnesota Forest Resources Council (MFRC) in its *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines*. These recommended sustainable practices have transformed forest management in Minnesota, and have been widely accepted by resource managers and landowners. Since the publication of the guidelines, however, climate change, invasive species, and parcelization have become distinct challenges that threaten the health of forests and require specific policy and management responses.

Key Natural Resource Conditions and Trends in Forestry Land Use

Northeastern Minnesota has approximately 23 million acres of broad areas of conifer forest, mixed hardwood and conifer forests, and conifer bogs and swamps. These forests are composed of a patchwork of private, state, county, federal, and tribal blocks of land. There are numerous large privately held parcels that are 500 acres or more, and several parcels over 1 million acres owned by corporations. In contrast,

the hardwood forests of the central and southeastern parts of the state, which cover about 12 million acres, have been more substantially fragmented and reduced to smaller patches. Approximately 85 percent of the remaining forestland in these areas is privately owned, and few of these parcels are larger than 500 acres. Only 0.2 percent of southern Minnesota forestlands are owned by industry (Minnesota Department of Natural Resources 2008).

Timber Industry Restructuring

Due to changes in international forest product industries, the timber industry is undergoing major restructuring, affecting forest management and forest holdings in northern Minnesota. From 1989 to 2003, individuals accounted for 94% of all forest acreage purchased and 89% of all acreage sold, indicating a slight but gradual shift in forestland ownership out of corporations and to individuals.

Forest Ownership Changes/Parcelization

Parcelization is a trend in the northeastern forests where land holdings have traditionally been large. Parcelization is the division of larger blocks of forested land into smaller blocks with multiple owners. A recent study in Itasca County in northern Minnesota found that from 1989 to 2003, the average tract size of forest land sold decreased from 72 to 59 acres (18%); from 1991 to 2003 it decreased by 30% (Kilgore and MacKay, 2007). The MFRC recently identified parcelization as the single most important policy issue affecting the economic and ecological health of the state's forests.

Development and Forest Conversion

Development and forest conversion, the changing of forestland to any nonforest use such as commercial or residential development or agriculture, is a trend in all forested areas of the state. Forest parcelization is also linked to forestland conversion. In a study of land parcelization in Itasca County, 54% of the land splits (parcelization) from 1999 to 2006 occurred on

previously undeveloped land, and 68% of the splits had building value added within seven years after division (Kilgore et al. 2007).

Drivers of Change for Forestry Land Use

Forest systems in Minnesota are vulnerable to many global environmental change factors, including fragmentation, invasive species, climate change, and increased atmospheric carbon and nitrogen. They affect hydrologic function. These drivers interact in ways that can escalate their individual and aggregate impacts. For example, climate change and nonnative biological invasions have the potential to dramatically impact community composition and ecosystem structure and function. These impacts range from species diversity to nutrient cycling and hydrology.

Habitat Fragmentation

Forest conversion from development and parcelization can lead to forest fragmentation, or the creation of many small forest "islands" separated by nonforested areas. Fragmentation erodes the functioning of the remaining natural system, reducing the forest's resilience to disturbance and change including climate change and invasive species. Fragmentation also endangers habitat for native wildlife species, especially for larger mammals such as bears and wolves, which require large tracts of undeveloped land.

Invasive Species

Minnesota now has several invasive species that are harmful to forests, such as the gypsy moth, buckthorn, and earthworms. Fragmentation and conversion contribute to the spread of invasive species and can lead to uneven growth as edge species are favored over interior species.

Climate Change

Forests are directly affected by increased CO₂, including changes in plant productivity and response to insects and diseases. They are also affected by climate change, including changes in species composition of native communities. Other factors such as fragmentation and invasive species exacerbate this effect.

Hydrologic Modification and Solids, Nutrient, and Contaminant Loading

Conversion of forestlands is a significant hydrologic modification that can negatively affect water quality. A forested landscape will infiltrate at least 90% of the volume of water from rain events in an area, preventing runoff. After conversion only 10% of the volume may be infiltrated, resulting in significant runoff.

Forestry Land Use Recommendations

The overall strategy of these recommendations is to increase forest ecosystem resilience through maintenance of large blocks of forested land and forest resource health. This requires protection of forestlands against conversion to other uses, and conservation of working forestland resources through sustainable management.

Land Use Recommendation 8: Protect large blocks of forested land



Description of recommended action. The objective of this recommendation is to identify, prioritize, and promote protection of large blocks of forested land, focused on areas that are adjacent to large publicly held blocks and that are at risk of parcelization, conversion, and fragmentation.

8A. Identify forestlands for protection

Research is needed to indicate the location and characteristics of land that should be targeted for protection. Specifically, research is needed to:

- Provide a detailed map of land parcelization trends in Minnesota
- Identify targeted blocks of threatened land near large blocks of publicly held land

8B. Prioritize forest lands for protection

Prioritization should be based on proximity to large blocks of already protected land (both public and private) to maximize the resiliency of the forests, and should include a specific focus on protecting working forests so that forest products can continue to support regional economies of Minnesota. Protection should focus on at-risk and high-priority lands (generally 100 acres or more) in both the Laurentian mixed forests and eastern broadleaf forests.

8C. Support and promote permanent protection of forest lands

Permanent protection of forestlands through fee title acquisition or conservation easements will need to be supported and promoted to landowners through financial incentives, education, and technical assistance, including:

- Increase financial incentives for conservation easements, including conservation tax credits, income tax deductions, and/or reductions in estate taxes
- Advocate for statewide or regional funding for land acquisition and tax incentive programs (tax breaks) for landowners who take appropriate steps to protect their forestland
- Provide information and technical assistance (on- and off-site) to interested landowners on easement practices and funding sources
- Establish and maintain partnerships to aid in identifying and protecting priority forestland through conservation easements (Minnesota Department of Natural Resources, 2008)

- Ensure that all easements meet statutory requirements and DNR policies, including those regarding legal description, appraisals, environmental review, easements drafting, record keeping, and title review (Minnesota Department of Natural Resources, 2008)

Land Use Recommendation 9: Assess tools for forest land protection



Description of recommended action. This recommendation is focused on identifying, examining, and monitoring the impacts of diverse tools in order to assess their effectiveness for forest land protection.

The state can make a spectrum of investments to protect forestland. Some directly support permanent protection of forestland, such as fee title acquisitions, conservation easements, and tax policies. Others, such as cost share, forest certification, and forest stewardship planning, support forestland protection indirectly by supporting sustainable management practices.

Each tool has a role in protecting Minnesota's forests, and the choice of tools depends on many factors, including site-specific conditions and cost effectiveness. Protection tools have been successful in protecting critical forest lands in Minnesota, but a comprehensive assessment of their appropriateness in various settings is lacking.

Research is needed to assess and compare the effectiveness of these diverse tools at protecting forestland under different site-specific conditions so that tools are best matched with the forestlands that they aim to protect. Additionally, given the limited resources available to the state and private land-protection organizations, it is important to determine which tool provides the greatest benefits at the least cost. Specifically, research is needed to assess:

- The effectiveness of diverse forest protection tools, including the cost effectiveness, particularly comparing conservation easements to fee title acquisition

- The role that agencies and nonprofits should play in developing and implementing forest protection tools
- Management restrictions that are required to encourage compliance with BMPs on forestlands
- Funding levels that are required to encourage landowner participation in BMPs

This research should then be used to create a toolbox of protection tools that can be adapted to address regional or site-specific pressures, and to the goals of specific forest owners.

Land Use Recommendation 10: Support and expand sustainable practices on working forested lands



Description of recommended action. The objective of this recommendation is to promote and implement sustainable forest practices in working forests in Minnesota. This strategy builds on the accomplishments of the MFRC voluntary guidelines. Strategies include education, financial incentives to landowners, research and demonstration, and direct investment in specific management strategies.

10A. Educate consumers on benefits of certified wood to increase the demand for sustainably raised timber in Minnesota

- Build networks of retailers, private industry, and educators to increase public awareness of forest certification standards.
- Educate retailers and consumers about environmental and economic benefits of sustainable harvest and growing practices.

10B. Educate landowners and forest managers on best management practices to protect working forests

- Increase funding for BMP education for both the public and forest products industry.
- Expand impact of voluntary management practices as described in the MFRC's management guidelines.

- Educate landowners, loggers, and forest managers on biomass harvesting BMPs (e.g., master logger certification program).
- Improve peer-to-peer networks to increase BMP information sharing among private landowners.

10C. Promote collective/cooperative management of forestlands at a landscape level in order to increase the multiple benefits of forests (timber, air quality, carbon sinks, water quality, etc.)

- Promote landscape-level cooperation and collaboration between public and private sectors to increase management.
- Support MFRC ongoing efforts in this regard.
- Develop multistakeholder statewide networks to facilitate implementation of BMPs on private and public land.

10D. Provide incentives for sustainable forestry practices

- Encourage cost sharing on forests and private timber sales (to obtain adequate regeneration, especially of oak).
- Emphasize state cost-share programs based upon soil erosion and water quality impacts.
- Identify and mobilize programs to compensate landowners for land taken out of production.
- Provide incentives to landowners who practice BMPs on private land.
- Inform and assist landowners on cost-share practices and funding sources.
- Provide professional assistance to forest owners to assist in forest management in order to optimize forest resources and fulfill specific forest owner goals without jeopardizing sustainability and biodiversity.

10E. Develop and test new management practices to improve ecosystem resilience

Invest in research and demonstration areas that identify, examine, and monitor the impact of management scenarios on ecosystem resilience and increase

understanding of the impact of climate change and other key drivers on forested ecosystems.

- Focus on innovative management practices that enhance the resilience of the forested ecosystem, forest management as a carbon sequestration tool, and effectiveness of BMPs, and develop effective monitoring protocols that help inform management decisions.
- Create areas large enough to encompass some landscape-level functions (300-3,000 hectares) to help expand understanding of the impact of climate change, invasive species, and other system drivers on the state's forested ecosystems.
- Undertake research to broaden understanding of the interplay between climate change, non-native species invasion and other global environmental changes, the primary and secondary impacts of invasive species from a local and landscape level, and the potential for controlling these species.
- Use these areas for educational opportunities. Examples of sustainably managed sites, comparisons between sites impacted and not impacted by nonnative invasive species, and examples of services healthy functioning forest can provide, can help increase public understanding of the impacts global change can have on the landscape and land.

10F. Support the use of fire to increase forest health and biodiversity

Use of fire is supported by management strategies currently being developed by DNR for newly updated Ecological Classification System (ECS) plant community classifications.

- Use fire in pine and oak forests to encourage regeneration that would result in overall improvement in habitat quality benefiting multiple species.
- Fire as a BMP could be used in conjunction with biomass harvested for energy production.
- Support development of infrastructure necessary to conduct prescribed burns. This may include staff, training, and trucks.

Impacts on natural resources. The protection of large blocks of forestland is a fundamental action to increase resilience of forest ecosystems. It prevents parcelization, conversion, and fragmentation, allowing for the movement and migration of species in the face of climate change; creates buffers to nonnative species invasion; and supports resilient forested systems that continue to function properly and provide services to the surrounding landscape. The implementation of sustainable management practices on public and private forested lands will also help increase the resiliency of forests to climate change and other drivers and to restore connections between forest fragments.

Relationship to existing programs, laws, regulations. These recommendations support, update, and expand on activities currently underway at the UM, the MFRC, the Minnesota Forest Legacy Program/Partnership, and the DNR. For example:

- *Minnesota Forest for the Future* (Minnesota Department of Natural Resources, 2008) stated as a primary goal “[t]o promote strategic conservation of private forests.” Key strategies recommended to reach this goal include: preferentially protect the largest, and most intact blocks of forest; preferentially pursue projects that will result in the greatest amount of linkage between forested land; and preferentially encourage projects that are linked to regional and statewide conservation efforts and that create a cumulative conservation effect.
- The Forest Legacy Program promotes the use of permanent working conservation easements. The Forest Legacy Partnership successfully completed the most successful forest protection effort in more than 10 years when it protected 51,163 acres in state forests in Koochiching and Itasca state counties. The forested land is a key link to connect more than 500,000 acres of critical habitat.
- The MFRC provides management guidelines in *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management*

Guidelines for Landowners, Loggers and Resource Managers (MFRC, 2005).

- The UM and DNR provide research, demonstration, and educational projects:
 - UM Minnesota Futures Phase II project
 - UM Integrative Graduate Education and Research Traineeship (IGERT) Invasive Species Program
 - DNR Forest Certification Program
 - University of Minnesota Forest and Climate Change Project
 - DNR Forest Legacy Partnership

Time frame. Work could begin as soon as funding is available.

Geographical coverage. In general, attention should be given to the north, north-central, and southeastern portions of the state to areas where the drivers are currently impacting the landscape.

Challenges. To ensure acceptable outcomes, all three recommendations require the cooperation of diverse stakeholders with differing goals and strategies for protecting Minnesota’s forests (e.g., landowners, researchers, forest managers, forest product industry representatives, wildlife and water quality professionals, governmental and nongovernmental organizations). It may be a challenge to maintain coordination and cooperation among these diverse stakeholders. This will require transparency, with open and constructive dialogue regarding goal setting, acquisition processes, and monitoring. Public and private hearings and meetings to determine needs/goals of various stakeholders would help to facilitate open communication and trust.

Costs. According to *Minnesota Forests for the Future* (Minnesota Department of Natural Resources, 2008) the estimated costs to protect forestland in Minnesota vary from \$125 to \$250 million to meet Laurentian mixed forest protection targets, to \$40 to \$60 million for eastern broadleaf protection targets.