

APPENDIX IX

Short Descriptions of Recommendations

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Habitat Recommendations

Land Protection

Habitat Recommendation 1: Protect priority land habitats



Description of recommended action. The SCPP has identified many critical land habitats throughout the state based on an integrated approach that considers such issues as SGCN, outdoor recreation such as hunting and fishing, protection of water quality, and threats to these resources (Figure H7). Critical land habitats were identified through a combination of existing government, UM, and selected private data sets. These data sets were spatially explicit and, with rare exception, statewide (Table H1). The criteria for critical habitat identification were developed by a group of public and private stakeholders and optimized to provide the most benefit to the most constituents.

These areas have been prioritized for conservation and preservation. A variety of public and private mechanisms are available to protect these areas, including acquisition, conservation easements, and restoration/remediation of impacted habitats. Public education will play an important role in protecting priority land habitats, and coordination among pub-

lic, nonprofit, and private entities to protect critical habitats will be increasingly paramount.

The SCPP outlines important land habitats that benefit wildlife, fish, water quality, and outdoor recreation in the context of threats to these important natural resources. The SCPP allows considerable flexibility for conservation of lands and appropriate protection of economic activity such as logging or other compatible uses. Conservation and protection of these land areas will require multiple mechanisms and a coordinated effort among local, county, regional, state, and national public agencies; nonprofits; and private entities. Of particular importance are rare land features and areas such as native prairie and savanna that have been converted to other land uses. This is among the reasons that SOBS received a relatively high weight in the integrated analysis (Table H1).

The state must further strengthen its leadership to coordinate and stimulate efforts for the protection of these critical land areas among current and potential partners. This activity would include identification of relevant landowners; identification of the most cost-effective measures for protection, restoration, and education on the importance of the area; and development of a comprehensive plan to ensure the economic, environmental, and social benefits of protection.

The integrated mapping analyses provide a basis for and opportunity to develop regionally specific strategies for conservation and preservation of Minnesota's critical habitats, using the suite of policy and incentive options from voluntary implementation of BMPs to permanent land acquisition. Implicit within this recommendation is continued support for ongoing programs such as acquisition of the 54,000 acres of private land within state parks. Acquisition of these lands should remain a high priority because they reduce fragmentation and help to maintain large, intact ecosystems.

Habitat Recommendation 2: Protect critical shorelands of streams and lakes



Description of recommended action. A holistic approach is needed for shoreline protection that integrates acquisition with diverse private-land protection strategies such as conservation tax credits, trading of conservation tax credits, BMPs, shoreland regulations and incentives, zoning ordinances, conservation development, and technical guidance for shoreland owners. Fully funded acquisition programs are essential, but not sufficient to protect large enough areas of shoreland to ensure water quality and habitat protection, and thus sustain healthy lake, river, and stream ecosystems. It is doubly important to protect these aquatic habitats at a large scale to make them more resilient to the significant warming and altered precipitation projected for Minnesota over the next century (Appendix IV). Therefore, the state needs a diversity of economic incentives and other tools for private landowners.

2A. Acquire high-priority shorelands

The highest priority shorelands within each of Minnesota's 22 ecological subsections should be permanently protected through acquisition. This is one essential component of a multistrategy approach to preserving the clean water legacy that Minnesota's citizens and visitors are used to experiencing. Acquisition may protect critical shoreland habitats

from degradation; assure public access for fishing, hunting, wildlife viewing, and natural resource management, which is especially important given the continuing loss of access to natural shores; and provide areas for education and research. Suggestions for prioritizing shoreland acquisition appear in several recent reports, including DNR's 2008 aquatic management area (AMA) acquisition plan, the DNR long-range duck recovery plan, and a 2008 report identifying lake conservation priorities for The Nature Conservancy (TNC).

2B. Protect private shorelands via economic incentives and other tools

Minnesota should greatly increase the use of economic incentives and other tools for private landowners to protect shorelines and other sensitive land along lakes, especially along shallow lakes and shallow bays of deep lakes, and streams and rivers throughout Minnesota. This is also needed for riparian buffers around sinkholes in agricultural lands in southeastern Minnesota (see further discussion under habitat recommendation 7).

Protection of private shorelands should combine various tools, such as tax credits, conservation easements for shoreland protection and restoration, BMPs, technical guidance to shoreland owners, shoreland regulations, and zoning ordinances. It is especially important to scale up and combine these tools, for example, by providing technical guidance to landowners on how to implement BMPs on shorelands put under a tradeable conservation tax credit.

Tax credits could dramatically catalyze private shoreland protection. The idea is to provide state income tax credit for conservation easements. In their simplest form, conservation tax credits are applied to perpetual conservation easements or donations of fee-title land. Perpetual conservation easements could be donated to the state or legal land trusts. A further innovation is to allow trade of conservation tax credits among taxpayers: Landowners with

low state tax liability could sell their credits to landowners with higher tax liability, thereby giving landowners with low tax liability an incentive to become interested in making land conservation donations. Although conservation tax credits were initially conceived as a protection strategy for shallow lake habitats in agricultural areas, this approach could expand to protecting a broader array of shorelands (streams, rivers, lakes, wetlands) throughout the state.

Habitat Recommendation 3: Improve connectivity and access to outdoor recreation



Outdoor recreation was not one of the three focal issues chosen for the final SCPP; however, the State Comprehensive Outdoor Recreation Plan (SCORP) has already provided a comprehensive plan and the SCPP preliminary plan provided recommendations for research to support quality outdoor recreation in the future (see Appendix I). To complement these recommendations, the habitat team offers an additional recommendation regarding the important connection between habitat conservation and recreation and considering the distribution of historical and cultural resources in the state.

Description of recommended action. Land use patterns are changing in Minnesota. Lakeshore development is increasing, urban areas are expanding, and forests are being divided into small, privately owned parcels. These changes and others are affecting outdoor recreation. Land needs to be acquired, protected, and restored to provide Minnesotans and visitors an outdoor system where they can recreate.

Action should be taken to improve connectivity of and access to outdoor recreation areas (parks, natural areas, wildlife management areas, etc., Figure H30) and document the connectivity and experience opportunities through a statewide recreation system. Such connectivity would require enhancing connections among state, federal, and local government lands and facilities. Prioritization for acquisition,

protection, and restoration of the natural resource base that supports outdoor recreation should focus on large, contiguous land areas suitable for: natural resource-based outdoor recreation; shorelands; threatened habitat areas with opportunities to improve connectivity of underserved areas; and rapidly growing areas or areas where land use changes may limit future outdoor recreation opportunities.

The trends in recreational use and changes in land use patterns all support this recommendation. These primary drivers include land use conversion patterns and changes in population demographics in areas such as the Twin Cities metropolitan area and locations with lakes, rivers, and forests. Participation in hunting and fishing continues to decline, while non-consumptive activities such as wildlife watching and hiking remain stable or are growing. Increasing human population is projected to lead to an estimated rise in state park visitors, from 8.6 million in 1998 to 9.2 million by 2025. If energy costs continue to increase, there will be a growing demand for outdoor opportunities that limit the need to travel great distances for recreation.

Habitat Recommendation 4: Restore and protect shallow lakes



Description of recommended action. Minnesota should accelerate efforts to restore and improve shallow-lake habitat (including shallow bays of deep lakes) in priority watersheds in order to reduce the number of lakes in a turbid-water state, and to restore some of the 1,000-plus drained shallow lakes in the state. Active management of Swan, Christina, and Thief Lakes shows that many shallow lakes with poor water quality and little habitat can be restored through active management.

Sensitive shallow lakes frequently winterkill (fish); are subject to mixing from wind, surface use, and large fish (carp); and typically exist in either a turbid- or clear-water state. Unfortunately, most shallow lakes in the prairie and forest-prairie transi-

tion zones of Minnesota are in the turbid-water state. This is due to the combination of increased flows of water and nutrients into them from intensively drained and cultivated landscapes that surround them, and abundant populations of invasive fish (e.g., carp and black bullhead) that result from increased connectivity (i.e., ditches) and persist due to lack of natural winterkill. Some shallow lakes are so turbid that they are listed as impaired by the MPCA. Dense human housing development and inappropriate surface uses are also increasing threats to shallow lakes.

Funding is needed to purchase conservation easements around shallow lakes to restore their lake-sheds (small wetlands and grass buffers) and prevent development. Funding is also needed to install fish barriers to keep out invasive species such as carp. Finally, funding is needed for water control structures that state agency managers can use to conduct temporary drawdowns to consolidate and aerate sediments, induce natural winterkill of fish, and rejuvenate aquatic plants. The level of development and management of the landscapes around shallow lakes necessitates active in-lake management in order to maintain water quality and good habitat.

Habitat Recommendation 5: Restore land, wetlands, and wetland-associated watersheds



Description of recommended action. Minnesota must invest in prioritized areas to restore degraded and rare land features, wetlands (especially many that have been drained and converted), and watersheds associated with wetlands. This will provide benefits for wildlife, SGCN, water quality, and important ecological processes. This is especially imperative in the prairie and prairie-forest transition zones of the state. Restoration should consider the need to encourage landowners to restore these lands and compensate them above and beyond the fair market value of the land, since most sites are not for sale and high crop prices inhibit conversion of land

from agriculture to other uses. Consideration must also be given to using easements on private lands to achieve habitat restoration goals. It is imperative to recognize the huge loss of native prairie and small wetlands in the prairie region of Minnesota (99% and 90%, respectively). Wildlife does not require restored lands to be in public ownership to benefit from them as critical habitat. Restoration, however, is not only needed in the prairie regions, though it is of high priority there. Other land uses such as savanna and forests are also in need of attention. For instance, riparian forests need restoring, and regeneration of oak, white cedar, and white pine requires attention. Similarly, restoration of wetlands alone cannot restore their appropriate structure and function; restoration efforts must also consider the watersheds that drain into wetlands.

Habitat Recommendation 6: Protect and restore critical in-water habitat of lakes and streams



Description of recommended action. Accelerate and expand the relatively small current efforts to restore critical habitat for aquatic communities in near-shore areas of lakes, in-stream areas of rivers and streams, and deep-water lakes with exceptional water quality.

6A. Restore habitat structure within lakes

We recommend developing a program to restore the natural features of lakeshore habitats (shoreland, shoreline, and near-shore areas). The program would add woody habitat where it has been removed, and restore emergent and floating vegetation where it has been lost. The program would also work with lake-home owners and lake associations to achieve restoration goals.

Increasing development pressure along lakeshores has negative impacts on these species and water quality—and Minnesota's lakeshores are being developed at a rapid rate. The shallow areas in large lakes are crucial to fish, wildlife, and water quality.

An estimated 20% to 28% of the near-shore emergent and floating-leaf coverage has been lost due to development in bass and walleye lakes. On average, there is a 66% reduction in aquatic vegetation coverage with shoreland development. These declines in aquatic vegetation coincide with lower fish production and reduced water quality in lakes. Woody habitat losses are also occurring in Minnesota lakes but have not been quantified. Many fish depend on aquatic vegetation, woody habitat, and shorelines to provide spawning habitat, cover, and refuge from predators. Downed trees provide important in-lake structure, habitat, food, and shelter for fishes, frogs, turtles, water birds, and mammals. This woody habitat is also important for aquatic invertebrates such as snails and bryozoans. Turtles need to bask on dead-falls or floating logs. Near-shore downed trees also blunt waves and ice action that scour the lake bed. Because trees often grow slowly and their density has been reduced due to past shoreline alterations, this important habitat element in Minnesota lakes may not be replenished without substantial efforts.

6B. Protect and restore in-stream habitats

A priority for rivers, particularly the Mississippi River, is to reduce the negative effects of recreational boat traffic, especially from medium to large cruisers, on sensitive shoreline habitats. Stream-bank erosion from recreational boat wakes adds large sediment loads, which increases water turbidity and disrupts the growth of beneficial aquatic plants and reproduction of native mussels and some fish. Other habitat impacts include breakage of aquatic plants; impingement and various disturbances of fish and wildlife; and dislodging of woody debris that normally provides important cover and food production for fish, as well as habitat structure for turtles and birds. Systemic solutions include enforcing no-wake zones or no-wake periods in sensitive habitats, which requires revision of local, state, or federal surface water use regulations; and design of more river-friendly boats, which requires engineering research and development. Past education efforts and voluntary no-wake zones have not worked.

A priority for former prairie zones of Minnesota is to reverse the negative effects of stream channelization on in-stream habitats for fish and other aquatic organisms. Channelization has changed the hydrology of streams, which has then made them wider and more deeply incised. In many locations, negative effects of stream channelization have been exacerbated by removal of riparian vegetation and wetlands, and altered upland land use. Several approaches can be implemented to protect and restore in-stream habitats. Riparian vegetation can be restored to stabilize stream banks (several state and federal programs, such as RIM, CRP, CREP and CSP, can provide financial assistance). Two-stage channels (Figures H33 and H34) can be constructed where streams have been channelized to provide a flood plain to dissipate stream energy and allow the channel to remeander, which will provide more diverse habitat for aquatic organisms. Restoring wetlands and altering upland vegetation (state and federal programs provide financial assistance) will hold water on the landscape or allow for increased infiltration, both of which can help mitigate the altered hydrology of streams.

Minnesota has hundreds of low-head dams and culverts that restrict movement of aquatic organisms. Inappropriately sized culverts also may contribute to localized flooding. Removal of dams and installing culverts with increased capacity would improve connectivity of aquatic systems. An alternative approach to removal of low-head dams is to provide for fish passage through the dam (e.g., recent construction providing passage for lake sturgeon in the Wild Rice River). Opportunities to remove higher dams or alter them to provide fish passage should also be explored.

6C. Protect deep-water lakes with exceptional water quality

Clear lakes with large, oxygen-rich deep-water zones provide critical habitat for native cold-water fish such as cisco, lake whitefish, and lake trout in

Minnesota. In the summer, lakes stratify into three layers; an uppermost epilimnion, which is warmest and oxygen poor; a middle thermocline; and the lowest hypolimnion, which is coldest and oxygen rich. During warm summers, cold-water fish find refuge in the cold hypolimnion if it has sufficient oxygen. Only lakes with the most exceptional water quality maintain enough oxygen in the hypolimnion for cold-water fish to thrive. Climate warming and poor land use in Minnesota pose imminent threats to oxygen levels in these deep-water zones. First, increased duration of stratification from climate warming decreases their oxygen content late in the summer. Second, oxygen concentrations are reduced by poor land use when decaying organic matter from algae and plants, stimulated by high nutrient loading, consumes oxygen in deep water. Both of these threats have the potential to severely limit habitat for cold-water fish in Minnesota.

Deep lakes with exceptional water quality will represent important sanctuaries for cold-water fish as the climate warms in Minnesota. However, future deterioration of water quality would greatly jeopardize the ability of these lakes to provide that refuge. These potential refuge lakes are being identified by the DNR and the UM. Many of these lakes are the “crown jewels” of Minnesota and deserve special status in addition to their value as refuges from climate change. Examples include Ten Mile Lake in Cass County, Big Trout Lake in Crow Wing County, Big Sand Lake in Hubbard County, and Trout and Wabana Lakes in Itasca County. Also, these types of lakes are not completely limited to forested ecoregions. Big Watab Lake, located in agricultural Stearns County, and Square Lake, located in the Twin Cities metropolitan area, also represent lakes with excellent oxygen resources in the hypolimnion.

Once identified, lake watershed protection efforts should be initiated with a special commitment. These protection efforts could include land purchase, easement protection, and BMP implementation. Many are already “high-profile” lakes with ac-

tive and dedicated lake associations and local users. Implementation of high-intensity watershed and shoreland protection efforts would largely be welcomed. Protection of these lakes may actually be cost effective (high value for modest investment). Many are characterized by small, forested watersheds and protection efforts can be targeted at relatively few parcels with great cost efficiency.

Sustainable Practice

Habitat Recommendation 7: Keep water on the landscape



Description of recommended action. Retaining water on the landscape over broader areas and for longer periods is critical for improving water quality, reducing flooding, maintaining habitat for wildlife and game species, and enhancing biological diversity. The intent of this recommendation is to have water move more slowly across and through the landscape to return to more natural conditions. This need is acute in agricultural and urban landscapes of Minnesota. We suggest three strategies that complement other landscape-focused recommendations in this plan:

- Perennial vegetation
- Storm water controls
- Riparian buffers

Habitat Recommendation 8: Review and analyze drainage policy



Description of recommended action. The state should invest in a comprehensive review and analysis of laws relating to drainage, including Minnesota Statutes Chapter 103E, and recommend changes to the legislature that would remove barriers and facilitate the restoration of critical wetlands in order to improve water quality and aquatic habitats.

Knowledge Infrastructure

Habitat Recommendation 9: Overall research on land and aquatic habitats



Description of recommended action. The SCPP has developed and implemented a mechanism to integrate a portfolio of spatial data layers summarizing important natural resources and environmental threats in Minnesota. These data layers quantify the loss of native biodiversity, distribution of important outdoor resources (e.g., fish and wildlife populations), impairments to aquatic resources, degradation of critical ecological processes (e.g., nutrient cycling, predator-prey interactions), and locations of biologically significant and large, intact natural ecosystems. The spatial data layers were also examined in relation to where housing development was most likely to occur in the future, locations of road networks, current and future agricultural-bioenergy activity, and land ownership (Figures H2–H16).

Research is essential to improve understanding of the risk of extinction of Minnesota’s native biological diversity; continuing availability of quality outdoor recreation; and confidence in the ability to protect aquatic resources in the face of risks such as climate change, invasive species, and expanding human population. Information on important historical and cultural resources should also be researched and incorporated into decision making on conservation, protection, or restoration efforts.

The state of Minnesota should continue to appropriate funds for improving understanding of fish and wildlife populations, native biological diversity, and water quality, and mitigating the stressors that affect them.

Habitat Recommendation 10: Research on near-shore habitat vulnerability



Description of recommended action. There is a need to increase understanding of near-shore habitat vulnerability. This would be best accomplished through research on the human behaviors that degrade and destroy near-shore habitat, as well as pilot policies or programs that preserve or restore near-shore fish and wildlife habitat. Research can also address historic and cultural resources associated with near-shore habitat.

Habitat Recommendation 11: Improve understanding of ground water resources



Description of recommended action. Ground water is an indispensable natural resource for human activities and human health. Partly because ground water is a hidden resource, Minnesota has not yet adequately answered critical questions about it. We need to understand how much ground water we have, where we can find it, its quality, how it moves, where it is recharged, where it discharges, and how much we can safely tap, both seasonally and long term.

The state needs to make a major, sustained investment in the collection and assessment of information about ground water and its connection to surface waters. We need to fill information gaps at the site-specific scale and the scale of entire hydrologic systems, including aquifers and watersheds. Given the relatively complex hydrology in our state, Minnesota may be decades away from acquiring sufficient information to inform site-specific decisions about ground-water usage throughout the state. Filling critical information gaps at both scales is essential for achieving sustainable management of ground water that meets the needs of humans and habitats.

The overall goal of this recommendation is to develop a large-scale, hydrologic-system framework for understanding how today’s decisions may affect

tomorrow's needs. This systems approach will offer insights into the more strategic questions that are beyond the reach of the current site-by-site focus of decision-making for ground-water use. A systems approach will make it possible to answer questions about (1) how much water can be committed to human activities without adversely affecting ecosystems, (2) how much growth a specific region can sustain based upon its water budget, and (3) how land use changes and climate change may shift the whole equation.

Habitat Recommendation 12: Improve understanding of watersheds' response to multiple drivers of change



Description of recommended action. Effective water quality protection and restoration will require additional monitoring, research, and evaluation of aquatic and land responses to land use, climate, and other changes. While much is known within various spatial and temporal scales, interactions and responses across scales are not well understood. Research is needed to build the capacity of resource managers to understand and evaluate the multitude of factors that affect these resources across the state.

To accomplish this recommendation, investment is needed for research across many watershed scales to improve understanding of pollutants, pollution sources, movement across the watershed (e.g., hydrology), and physical, chemical, and biological responses. There have been significant advances in monitoring methods and technologies, plus increased funding (e.g., through the Clean Water Legacy Act). The use of biological monitoring has become better integrated with water quality. The next step to achieve a better understanding of watershed systems and an assessment of their health is to gain a more holistic and comprehensive understanding of how a water body and its watershed function. This would result in more effective protection, restoration, and conservation for both land and aquatic habitats.

A formal physical watershed evaluation monitoring effort is also needed to assess habitat and underlying geomorphic conditions as a component of Clean Water Legacy monitoring and assessment activities. Greater use of geographic information system (GIS) data layers and analysis tools is essential as data layers become more detailed and analytical techniques improve. The DNR Watershed Assessment Tool should be improved to enable the identification of priority habitat investment areas. Use of tools such as the U.S. Environmental Protection Agency (USEPA) Watershed Assessment of River Stability and Sediment Supply (WARSSS) procedures should be supported for developing and completing physical channel, bank, and watershed condition monitoring and evaluation.

The state lacks the basic information needed to understand how multiple drivers of change affect Minnesota's watersheds. The state should conduct a rapid assessment to gather baseline information on the physical, biological, and chemical conditions of streams important to understanding these effects.

Attention is also needed in the evaluation of the potential impacts of climate change on land and aquatic habitats. State-level studies are needed to improve projections of how climate change will alter habitats, the distributions of species, and the stressors that affect both. Studies are also needed to inform strategies that will support adaptation of biodiversity to a changed climate (see Appendix IV).

Habitat Recommendation 13: Habitat and landscape conservation and training programs for all citizens



Description of recommended action. The state should invest in education to improve public understanding of the need for better conservation, protection, and restoration of Minnesota's habitats and landscapes. Expanded education, information, and training efforts are needed to bring focus to the complexity of land, water, and land-water interactions in

a landscape context. These efforts must be directed to all citizens from K–12 educational levels to higher education, and the general public. A broad range of teaching and information sharing materials has been developed. Means of delivering the materials, goals for communicating them, and ways to measure success need yet to be developed.

As people have migrated to cities over the past 50 years, awareness of natural resources has declined. To attain a more informed constituency, whether as interested citizens or as professionals doing natural resources work, investment is needed. Technical information and transfer of that information is needed for people to grow an awareness of natural resources, and appreciation for monitoring, assessment, and data evaluation.

Land Use Recommendations

Community Land Use

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.

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.

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
- Conservation-based planning along a rapidly developing transportation corridor (involving multiple communities)
- Conservation-based planning resulting in an AUAR-certified comprehensive plan

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

- Provide financial assistance to communities to support implementation of conservation-based plans

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
- Improve agricultural land preservation tools
- Develop and deliver outreach materials
- Establish a Minnesota natural resources and development partnership
- Invest in building state assistance capabilities

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
- Update statewide land-cover databases and remote sensing capabilities

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

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.

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 motivate 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.

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.

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.

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.

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.

Agricultural Land Use

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.

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.

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.

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 impacts. With placement guided by more accurate digi-

tal 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.

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.

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.

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.

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.

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.

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).

6B. Investigate policy changes to reduce upland and gully 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.

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.

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

Forestry Land Use

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.

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.

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

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

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.)

10D. Provide incentives for sustainable forestry practices

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.

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.

Transportation Recommendations

Transportation Recommendation 1:

Align transportation planning across state agencies and integrate development and review across state, regional, metropolitan and county/local transportation, land use and conservation programs



1A. Institute interagency alignment of planning to coordinate transportation with other state planning cycles

The state should coordinate cyclical statewide plans across state agencies (e.g., MnDOT, Minnesota Pollution Control Agency [MPCA], DNR) and provide environmental data coordination and analysis, including determination of vulnerable ecological areas by resource, cumulative impact analysis and projection, performance standards and best practices research, and recommendations for land acquisition. MnDOT would continue to have the role of responsible governing unit (RGU) for surface transportation projects.

If implemented, integration would provide incentive for feedback systems through monitoring and strategic research programs, organize and align early review of projects, and promote nonstructural and structural practices and performance measures.

1B. Integrate streamlined statewide environmental transportation project review with other statewide and cross-jurisdictional planning, design, budgeting, and review programs

Adopt environmental interagency stakeholder involvement (streamlining) project planning protocols through coordination across state, metropolitan, and county/local transportation, land use, and conservation decision-making responsibilities.

Modify the highway project development process (HPDP) to create a cross-consultative regional

and local forum and an environmental team to lead federal- and state-mandated impact assessment. MnDOT and the EQB would create the forum and teams with participation of other review agencies, including MPCA, DNR, the Minnesota State Historic Preservation Office (SHPO), and metropolitan and county units.

Description of recommended action. A coordinated statewide interagency planning process around transportation and other statewide initiatives will enhance efficiencies and coherence of funding and other efforts with resource conservation objectives.

Once a project is approved in the annual review process associated with the STIP, the purpose and need statements that formed their environmental assessment parameters will have been set. Since these projects have already been prioritized at the MnDOT district level through the regional ATP using the STIP projection of costs of minimization/mitigation, they would be potential candidates for streamlined environmental review. When streamlined environmental assessment occurs, EQB and MnDOT (and in the cases of transit corridors, the Metropolitan Council and/or the counties that are the joint RGUs for the project) are responsible to align all interagency environmental processes and to set and coordinate project performance standards and best practices and develop monitoring. This process will have local coordination based on analysis and cross-consultation via a new ETAT process.

**Transportation Recommendation 2:
Reduce per capita vehicle miles of travel
(VMT), through compact mixed-use
development and multi- and intermodal
transportation systems**



Description of recommended action. The principal means by which VMT can currently be reduced are through reducing growth in lane miles and increasing intermodal and multimodal (including nonmotorized) transportation access and use. In the context

of an automobile and truck fleet that cannot turn over (i.e. be replaced by more efficient vehicles and new fuels) in less than a decade regardless of other conditions, current efforts should concentrate on supporting planning and design of compact, mixed-use urban and suburban development and corresponding intermodal and multimodal transportation networks. Existing and proposed MnDOT plans and processes (e.g., interregional corridor plan, ATP, ETAT) should be used as foundations for support of compact urban and suburban development.

2A. Use alternative transportation planning and design processes and tools to support compact mixed-use development

Incorporate expanded transportation demand modeling (TDM) and Access Management modeling and other related strategies in statewide and local planning and project design to enhance local multimodal and passenger intermodal access that supports compact mixed-use development and resource conservation. For example, expanded Transportation Demand Management (TDM) analysis of MnDOT interregional corridor commutesheds, (i.e., areas of service at peak across modes) could suggest alternatives to usual applications of the functional classification standards. It is also important to have uniformity among expanded TDM requirements across neighboring communities so cities that implement expanded transit and nonmotorized TDM are not penalized budgetarily for their efforts by placing themselves at a disadvantage compared to civil divisions that do not implement TDM.

2B. Provide incentives for compact mixed-use development

Encourage and prioritize qualified transit and nonmotorized system fiscal investments in the STIP for regions that integrate local resource planning and performance-standard based design for compact development (Figure T6). Incorporate economic and employment development into resource protection.

For example, focus these approaches on the Twin Cities metropolitan area and other employment and service centers.

2C. Augment and communicate information on practices and performance of compact mixed-use development and transportation

Conduct interdisciplinary research (e.g., case studies) to correlate VMT changes with types, locations and scales of development in relation to transportation demand and planning for systems and modes. Establish databases on VMT-related statistics for resource-sensitive roadway network design and for patterns, intensities and combinations of land uses in multimodal and passenger intermodal development. EQB could provide research coordination of state agencies (e.g., MnDOT, MPCA); counties and localities (including minor civil divisions), educational institutions, and nonprofit stakeholders and foundations. Use this information to develop planning and design toolkits for the state, counties, metropolitan and local communities, developers, and citizens that include performance standards scorecards of structural and nonstructural approaches to VMT minimization/mitigation (e.g., based on models of per capita/per household VMT by land use configuration).

Transportation Recommendation 3: Develop and implement sustainable transportation research, design, planning, construction practices, regulations, and competitive incentive funding that minimize impacts on natural resources, especially habitat fragmentation and nonpoint source water pollution



Description of recommended action. This recommendation seeks to minimize, adapt, and mitigate habitat fragmentation and nonpoint source pollution from surface transportation (and related land uses) through research and design linkages via EQB, MPCA, and other stakeholders with MnDOT, and

through expanded regulation and funding incentives for innovative project approaches and increased environmental innovation on roadway design standards.

3A. Develop research programs on habitat fragmentation and planning, design, and construction techniques for adaptation, minimization, mitigation, and restoration

Roads fragment habitat. Some species are more or less impacted by road network configuration, width, pavement and shoulder treatments, bridging, and sizes and types of culverts. Species are generally also benefited by vegetated edge design and management and grade-separated crossings such as bridges or culverts. While there is a body of existing research around the academic efforts of Richard Forman, Daniel Sperling, and others, the main foci of environmental mitigation of habitat loss are still largely practice-based. See, for example, the FHWA CSS Web site (<http://www.fhwa.dot.gov/context/index.cfm>). For cases, see <http://www.contextsensitivesolutions.org/>.

Research is needed to explain land-cover and species relationships to local and regional impacts of road functional classification changes (widening and/or curbing), new routes, bridges, culverts, and other projects. Further research is needed to document effectiveness of innovative techniques including hybridizations of the functional classification, CSD/CSS, and innovative crossings of water.

3B. Develop research and design linkages of nonpoint source pollution to surface and ground waters from right-of-way and adjacent land uses that would improve performance of roadway-based infrastructure in relation to hydrological resource resilience and overall stability

In this state, water is always close, whether on the surface or in the ground. The cumulative and spatial impacts of transportation and associated land use development on water quality and aquatic habitat

are only beginning to be understood (Figure T7). Research is needed to develop a finer understanding of the spatial and biophysical dynamics and metrics of transportation-induced contamination of water, especially surface water, but in areas of high permeability, also ground water. Research on fate to ground and surface waters by land cover, land use, and soil types is needed to improve statewide storm-water performance standards for sediments and contaminants TMDLs. These standards could inform review of all transportation projects for NPDES permits as recommended here. The research would identify issues and model and test hypothetical conservation planning, design, implementation, and management practices across scales.

3C. Implement a standard baseline of habitat fragmentation and nonpoint discharge review for all projects that increase impervious highway roadway or drainage infrastructure surface in Minnesota

Require all new roadway projects or functional classification upgrade projects on existing roads to secure NPDES permits.

This recommendation could link project development more closely to comprehensive habitat data and impact analysis via the connection between the MnDOT statement of project purpose and need and environmental review. The statement of purpose and need provides the basis for developing a range of reasonable alternatives and, ultimately, identification of the preferred alternative. It also sets budgetary frameworks. If properly described, it also limits the range of alternatives that may be considered reasonable, prudent, and practicable in compliance with Council on Environmental Quality (CEQ) regulations, Section 4(f) of the Executive Order on Wetlands and Floodplains, and the Section 404(b) (1) guidelines. Further, it demonstrates the problems that will result if the no-build alternative is selected (<http://www.dot.state.mn.us/tecsup/xyz/plu/hpdp/book1/2b/class1/purpose-need.html>).

3D. Pilot incentive program grants for habitat and water-quality conservation design and construction innovations in transportation projects

The state should consider creating a grant program which would offer grants to MnDOT, counties, and local governments for transportation projects that demonstrate new or catalytic conservation approaches to road and related drainage design, development or (re)construction (Figure T8).

Energy Recommendations

Goal A

Promote alternative energy production strategies that balance or optimize production of food, feed, fiber, energy and other products with protection or improvement of environmental quality, including:

- water quality and water resource supply
- wildlife habitat
- greenhouse gas emissions
- soil quality and critical landscapes

Energy Recommendation 1: Develop coordinated laws, policies, and procedures for governmental entities to assess renewable energy production impacts on the environment



Develop laws, policies, and procedures for governmental entities to assess and manage the cumulative impacts on the environment of proposed and established energy production facilities, focusing on both individual and combined impacts. Information from this effort should be used to develop a biennial report to the legislature that informs the direction of the statewide conservation planning strategy.

Description of recommended action. Minnesota Statutes 116D.10-.11, require state agencies and the governor to prepare a biennial report to the legislature on efforts to address Minnesota's energy and environmental policies, programs, and needs. This requirement provides an ongoing vehicle within state government for internalizing, integrating, and tracking implementation of recommendations developed by the SCPP. Further, while the SCPP lays much of the foundation for future strategy reports, these reports will need to address other issues and describe how SCPP recommendations fit with them. For example, biofuel production initiatives are one component of a proposed package for meeting state greenhouse gas emission reduction goals. In addition, they are potentially a significant vehicle for addressing impaired waters. The biennial strategy report must ensure that these efforts complement one another (along with other state goals, such as enhancement of wildlife habitat) and that they are kept on track. This report would integrate information coming out of the permitting process for individual biofuel plants to paint a statewide picture of how energy production in Minnesota impacts state resources.

Two actions are needed. First, the law should be amended to explicitly reference the SCPP and to streamline requirements. Second, strategic investments are required to build state capability to develop biennial assessments and track progress across issues. A third package of actions, those investments needed to follow up on other conservation strategy recommendations, will contribute to the foundation upon which biennial assessments will be based.

Energy Recommendation 2: Invest in farm and forest preservation efforts to prevent fragmentation due to development guided by productivity and environmental vulnerability research

LP

Description of recommended action. Farm and forest fragmentation is a serious threat to wildlife habitat and ecosystem biodiversity. Expansion of urban

and agricultural areas often produces fragmentation of forests, and urban expansion reduces the land resource available for producing food, feed, fiber, and fuel. Strategies and policies are needed to protect farms and forests, and prevent fragmentation. The 2008 legislature provided a \$53,000 grant to the Minnesota Forest Resources Council (MFRC) to match \$150,000 in funding from the Blandin Foundation and Iron Range Resources for a study of forest parcelization and development, an assessment of available policy responses, and policy recommendations to the 2010 legislature. The 2007 legislature provided a \$40,000 grant to the UM Institute on the Environment that built on earlier MFRC research to assess potential impacts of parcelization and development on wildlife habitat and biodiversity in northern Minnesota. The state should consider recommendations from these studies relative to potential changes in policy or law, and relative to potentially funding specific proposals to prevent forest and farmland fragmentation due to development.

Energy Recommendation 3: Invest in perennial biofuel and energy crop research and demonstration projects on a landscape scale

SP

Invest in research and demonstration projects on a landscape scale to evaluate management and harvest techniques and yield potentials for various perennial biofuel crops (including monocultures of perennial grasses or woody biomass and polycultures) on different soils and agroecoregions throughout the state.

Description of recommended action. Based on nationwide analyses of potential biomass resources done by the U.S. Department of Energy (DOE) and USDA, energy crops are expected to play a major role in development of biomass resources for next-generation biofuels or carbon-neutral electrical generation. Coordinated research and policy experimentation should be carried out to develop and refine renewable energy production systems based on diversified biomass farming that emphasizes perennial

biomass crops. This initiative has great potential to improve environmental quality and support economic revitalization in rural Minnesota, while providing large amounts of biomass for renewable energy and bio-products. Developed properly, diversified biomass farming can help support current production agriculture while enhancing rural economic opportunities, producing locally grown renewable energy, and addressing important statewide water quality and environmental issues. In order to make energy crops a practical reality in the state, work is needed to improve yields through genetics and through identification of the optimal sites and BMPs for these crops. The state should support demonstration projects that bracket the various parts of the state so both yield and environmental questions associated with perennial crop production for given state locations can be ascertained in a timely manner. Existing data generated by the MFRC on forestry issues and county-based agricultural production data developed by the Center for Energy and Environment may be used to determine biomass availability. Opportunities and limitations associated with use of these resources should be identified. The effects of various assumptions about environmental impacts and biomass availability should be analyzed.

To move forward on commercial-scale pilot renewable-energy projects based on diversified biomass farming, it will be necessary to take a comprehensive approach to establish a bio-refining system that integrates production, processing, feedstock conversion/refining, and end-use market applications including but not restricted to energy production.

Energy Recommendation 4: Develop policies and incentives to encourage perennial crop production for biofuels in critical environmental areas



Invest in research and develop policies and financial incentives to encourage perennial crop production for biofuels on expiring CRP lands and other

environmentally sensitive or low-productivity lands. These research efforts, policies, and incentives should result in a balance between profitability and productivity on one hand, and benefits to the environment and wildlife habitat on the other hand.

Description of recommended action. The state should develop firm policies that would encourage the growth of energy crops on conservation lands and marginal farmlands and also reflect environmental and ecological needs for animal habitat and water resource conservation. There is currently an economic incentive for producers to plant productive expiring CRP land with row crops and small grains. Currently, there do not appear to be economic incentives for farmers or growers to grow perennial energy crops on these expiring environmentally sensitive lands. Policies and incentives are needed to encourage perennial biofuel crops on the most productive expiring CRP lands. Managers of low-productivity CRP lands should be encouraged to re-enroll them in conservation programs.

Energy Recommendation 5: Invest in data collection to support the assessment process



Invest in data collection to support the assessment process described in energy and mercury recommendation 1.

Data collection is needed in the following areas:

- Water quality
- Water resource sustainability (surface and ground water)
- Wildlife habitat and biodiversity
- Invasive species
- Land use changes
- Soil compaction, cover, and residue levels
- Infrastructure and storage needs for alternative fuel strategies
- GHG emissions

Description of recommended action. Minnesota needs a comprehensive approach to monitoring the cumulative impact of its energy production on the state environment. Data collection to support the monitoring and assessment of energy production should cover every step of the production process, and has the potential to inform the biennial report described in energy recommendation 1. Currently, many of the data needs listed above are incomplete or lacking entirely. Minnesota should fund data collection in these categories in locations around the state.

Energy Recommendation 6: Invest in research to determine sustainable removal rates of corn stover and to establish incentives and Best Management Practices (BMPs)



Invest in research to determine sustainable removal rates of corn stover for animal feed and biofuel production, and to establish incentives and BMPs for mitigating the adverse impacts of corn stover removal on soil carbon and erosion.

Description of recommended action. There is currently a debate among researchers and practitioners regarding how much corn stover may be removed from a field for biofuel or animal feed processing without significant negative impacts on soil carbon and erosion rates. Since the corn stover biofuel industry is close to being operational, the answer to this question in the Minnesota context is needed as soon as possible. If negative impacts of corn stover removal may be mitigated through farmer-installed BMPs (riparian buffer strips or cover crops), the state should encourage adoption of these BMPs.

Energy Recommendation 7: Invest in research to review thermal flow maps for Minnesota



Invest in research to review current thermal flow maps for Minnesota to assess their validity/accuracy,

and if necessary develop improved thermal flow maps, with the goal of informing geothermal power development in Minnesota

Description of recommended action. As a first step, the existing heat flow map for the state that was produced some years ago should be critiqued by experts from the Minnesota Geological Survey and their counterparts at the NRRI. Recent investigations of the current map seem to indicate that the existing projections for heat flow may be significantly underestimated due to the sampling technique used in the original data collection effort. Other countries at similar or higher latitudes, most notably Germany and Denmark, are adopting deep geothermal energy systems in order to produce necessary electrical power while reducing GHG emissions. A critical tool for assessing the viability of deploying this environmentally friendly energy technology is a thermal flow map for the state that relates the depth of the resource to the expected energy capture that may be possible.

Energy Recommendation 8: Invest in applied research to reduce energy and water consumption and green house gas emissions in present and future ethanol plants, and enact policies to encourage implementation of these conservation technologies



Description of recommended action. Minnesota should invest in applied research and demonstration projects that reduce water consumption, energy use, and CO₂ emissions at corn-based ethanol plants.

Energy Recommendation 9: Invest in research to determine the life cycle impacts of renewable energy production systems



Invest in research to determine the life-cycle impacts of renewable energy production systems on the rural economy, greenhouse gas emissions, water sustainability, water quality, carbon sequestration, gene flow

risks, and wildlife populations at landscape and regional scales while building on previous studies. This research should be used to direct the development of the renewable energy industry in Minnesota, including the storage and infrastructure needs associated with alternative fuels.

Description of recommended action. This recommendation is compatible with energy recommendations 1 and 5 in that it aims to estimate the cumulative impact of Minnesota's renewable energy development through data collection and analysis. Basically, the recommendation is that energy policy and incentives at the state level take a systems view, accounting for the resource benefits and impacts associated with each stage of energy production, transport, consumption, and associated waste processing. Research will be needed for legislators, citizens, and industry to make informed decisions about these benefits and impacts. Language to this effect should be added to legislation relevant to alternative energy development.

Energy Recommendation 10: Invest in research and demonstration projects to develop, and incentives to promote, combined wind power/biomass, wind power/ natural gas, and biomass/coal co-firing electricity projects



Description of recommended action. Integration of various energy production techniques that can help optimize the energy production system is an important opportunity for local communities, medium-size commercial and industrial users, and institutions in the state. As shown with the energy modeling work at the UM Morris, campus, a combined wind and biomass energy system allows overall optimization of energy production and the potential of almost complete energy self-sufficiency for the institution. The adoption of combined systems allows energy storage, peak loading, and stable energy generation issues to be addressed in a holistic fashion. For rural applications where biomass availability is high and wind conditions are favorable, systems can be envi-

sioned where a wind turbine system is coupled with a biomass gasification system to enhance the storage of off-peak power through generation of hydrogen and oxygen using water electrolysis. The produced gases then can be utilized to help facilitate improved gasifier operations. The stored oxygen can be used to displace air in the gasifier combustion process, and the hydrogen can be added to the producer gas to enhance its chemical potential to produce a syngas for natural gas replacement or additional power generation. The enhanced syngas can also be utilized to produce liquid fuels for use locally. Additionally, wind power/natural gas and biomass/coal electrical generation projects should be demonstrated that will allow GHG reductions while stabilizing electrical generation capacity in the state.

Energy Recommendation 11: Invest in research and enact policies to protect existing native prairies from genetic contamination by buffering them with neighboring plantings of perennial energy crops



Description of recommended action. In developing Minnesota's perennial biofuel industry (see energy recommendation 3), varieties may be selected for widespread planting that are not native to Minnesota, or that have been genetically modified from native plants. These biofuel plantings have the potential to genetically contaminate the state's native prairie remnants if they are close to these ecosystems. Research should be undertaken on the potential for this contamination, and policies should be developed to prevent it through mandated buffer plantings.

Energy Recommendation 12: Invest in efforts to develop sufficient seed or seedling stocks for large-scale plantings of native prairie grasses and other perennial crops



Description of recommended action. If perennial crops are to become a significant component of biofuel production in Minnesota, sufficient genetic stock for large-scale plantings will be necessary.

Goal B

Promote a healthy economy, including strategies that promote local ownership of alternative energy production and processing infrastructure, where appropriate.

Energy Recommendation 13: Invest in research and policies regarding “green payments”



Invest in research and policies on implementation strategies and optimal pricing schemes for green payments. These payments may be applied to perennial energy crop production on expiring CRP land, in impaired watersheds, on environmentally sensitive or low-productivity land, on DNR working lands, and on annual cropland. Multiple tiered payments for water quality, carbon, wildlife, fuel production, and other benefits may be considered, and special attention should be paid to helping producers through the transition period for perennial energy crop production. Knowledge and insights gained from previous multifunctional fuelshed experiments (at Waseca, Madelia, and UM Morris, for example) should be applied.

Description of recommended action. This recommendation fits well with energy recommendation 2. If adopted together, these two recommendations would strengthen the state’s efforts to protect environmentally sensitive land from intensive production, while providing benefits to farmers, local communities, natural resources, and wildlife. A green payment program should be informed by the most up-to-date scientific information on how biofuel production strategies impact natural resources. Farmers should be encouraged to plant perennial energy crops appropriate to their region (see energy recommendation 1).

Energy Recommendation 14: Investigate opportunities to provide tax incentives for individual investors in renewable energy (e.g., individuals who wish to install solar panels)



Description of recommended action. The state should make it easy and cost effective for individual homeowners or businesses to get their electricity from solar, geothermal, or wind power sources they install themselves. The specific financial mechanism needed to accomplish this goal should be developed in consultations between economists, policy makers, and citizen stakeholders. Other states (such as Massachusetts) have programs that might serve as an example.

Energy Recommendation 15: Invest in efforts to develop, and research to support, community-based energy platforms for producing electricity, transportation fuels, fertilizer, and other products that are locally/cooperatively owned



Description of recommended action. Many renewable energy sources (e.g., wind, biomass, and solar power) are located in the rural parts of the state. The localized development of alternative energy systems that can be placed at the source or nearby the source of the biomass materials will reduce the problems associated with logistical movement of unconsolidated biomass and reduce the transportation costs for biomass energy conversion. At the same time, the production and use of energy and energy products on a local basis will reduce infrastructure costs associated with power and fuels distribution. Both factors should allow localized development of smaller scale alternative energy systems that will benefit the local rural communities and add valued products to their economies. The state should encourage the development of these localized alternative energy systems by adoption of policies and incentives to facilitate their adoption. In addition, research and demonstration for systems that can facilitate the implementation of

this localized energy solution should be supported. Part of this support will involve transferring the lessons learned from successful community-based energy platforms (e.g., at UM, Morris; and Madelia, Coleraine Minerals Laboratory) to other communities interested in developing their own renewable energy platforms. The integration of local waste streams into energy production mechanisms is a key part of this recommendation.

Goal C

Promote efforts to improve energy conservation and energy efficiency among individuals, businesses, communities, and institutions.

Energy Recommendation 16: Provide incentives to transition a portion of Minnesota’s vehicle fleet to electrical power, while simultaneously increasing renewable electricity production for transportation



Description of recommended action. Powering Minnesota’s current transportation fleet solely with biofuels or fossil fuels is not feasible in the long term. Fueling our vehicles predominantly with ethanol would place enormous pressure on the state’s land resources, and would take land out of food production and conservation. Gasoline -powered vehicles contribute substantially to global climate change, and the rising price of gasoline creates an economic burden for Minnesota residents and businesses. Therefore, a state goal should be to transition the vehicle fleet away from dependence on both fossil fuels and biofuels. Powering vehicles with electricity derived from renewable sources makes sense from an ecological and sustainability standpoint, but is not yet economically viable. Several automakers have announced plans to sell electric vehicles within the next two years. However, the up-front cost for these vehicles will likely be more than for a conventional gas-powered vehicle. Minnesota should therefore provide appropriate incentives to encourage state residents

and businesses to purchase electric vehicles, with the goal of creating a robust electric vehicle sector in the state. The use of electric vehicles for commuting to work and while shopping locally in metropolitan environments where the commuting distances are relatively short should especially be encouraged.

These vehicles will require more capacity in the electricity sector, which should be provided with renewable sources (wind, solar, and geothermal). Some of this excess capacity may be mitigated by encouraging electric vehicle owners to charge their vehicles during off-peak hours (i.e., at night).

Energy Recommendation 17: Promote policies and incentives that encourage carbon-neutral businesses, homes, communities, and other institutions with an emphasis on learning from institutions already working toward this goal (e.g., UM, Morris)



Description of recommended action. Energy conservation and renewable fuel goals should be advanced simultaneously in Minnesota. Much more could be done to encourage businesses, homes, communities, and other institutions in Minnesota to dramatically reduce their carbon footprint through energy conservation and low-carbon fuel use. This recommendation fits well with energy recommendation 14—providing incentives for individuals to take advantage of solar, wind, and geothermal technologies would help them to become carbon neutral. Most likely, achieving carbon neutrality will require a portfolio of energy technologies and lowered energy consumption like that seen at UM, Morris (wind, biomass, etc.). Policies and incentives should be targeted to help individuals, businesses, communities, and institutions develop renewable energy portfolios appropriate for their situation.

Energy Recommendation 18: Implement policies and incentives to lower energy use of housing stock while monitoring the performance of improvements and calling on the utility industry to join in the effort



Description of recommended action. The envisioned housing improvements should consist of locally manufactured building material resources, especially those that use industry byproducts as their primary production feedstock. It is further recommended that the state develop specific policies and incentives to greatly improve construction practices for new residential homes. This can be accomplished by employing regional, sustainable building materials, and promoting the application of breakthrough systems approaches to new housing construction in an effort to drive down residential energy consumption. The UM has developed new technologies that present alternative means and methods for achieving vastly improved energy code compliance; these technologies should be further investigated to overcome implementation barriers.

Energy Recommendation 19: Promote policies and strategies to implement smart meter and smart grid technologies



Description of recommended action. Smart meter and smart grid technology is the next generation of electrical distribution technology. It provides for more local management and control of the energy used in the region and on site.

- The use of both smart meter and grid technology requires a series of advancements and changes in the current distribution practices. On a national level, there should be a uniform interconnection standard that would allow for a more robust mix of distributed and central-based power generation.
- At a state level, guidelines should be established for purchase of backup and supplemental power so that distributed combined heat and power (CHP) plants are not put at an

economic disadvantage when negotiating with investor-owned utilities.

- At a state level, investor-owned and electric cooperatives should be encouraged to move to smart grid technology and economic studies should be carried out to determine the benefit of incorporating distributed generation into the state's transmission grid.

Energy Recommendation 20: Develop incentives to encourage the widespread adoption of passive solar and shallow geothermal heat pump systems in new residential and commercial building construction; invest in research to develop improved technology for storing renewable energy



Description of recommended action. It is recommended that policies be adopted to encourage the widespread adoption of passive solar and shallow geothermal heat pump systems in new residential and commercial construction. Furthermore, it is recommended that incentives be developed to allow more widespread adoption of these technologies in existing structures where it is deemed to be a practical method for reducing water and habitat heating and cooling requirements. Utilities should be asked to incorporate specific programs to encourage structure owners to adopt these technologies in order to help meet the state's conservation goal as noted in existing Minnesota statutes.

Energy Recommendation 21: Develop standards and incentives for energy capture from municipal sanitary and solid waste, and minimize landfill options for MSW



Description of recommended action. A state mandate should be established that requires the capture of energy units from municipal solid waste (MSW) or municipal sanitary waste generated in the state. Appropriate statutory actions should be taken to establish targets for MSW use and minimization of landfill options for this waste material.

Energy Recommendation 22: Invest in public education focusing on benefits and strategies for energy conservation targeted toward individual Minnesota residents and businesses



Description of recommended action. Individual action is critical in reducing state energy demand, which will lower GHG emissions and reduce pressure on the land resource to provide alternative fuels. Specific examples of actions that should be encouraged may be found in the MCCAG recommendations. These include bicycle/pedestrian/public transit commuting, slower highway driving speeds, and purchasing energy-efficient appliances. There is a need to educate the public about lifestyle choices to reduce their energy consumption, particularly related to homes and transportation. Advertising and communications experts should be brought into this effort to disseminate the carbon reduction message in a creative way that reaches the broadest segment of the population possible.

Goal D (see related Appendix III)

Promote regulations, policies, incentives, and strategies to achieve significant reductions in mercury deposition in Minnesota.

Energy Recommendation 23: Develop mercury reduction strategies for out-of-state sources



Minnesota state agencies should work closely with the U.S. Environmental Protection Agency (USEPA) to develop mercury reduction strategies and assessment tools for the state, with the goal of meeting federal Clean Air Act and Clean Water Act standards. A mercury-reduction strategy should be developed that includes reduction of in-state demand for coal-powered electricity, and addresses mercury deposited in Minnesota from out-of-state sources.

Description of recommended action. Development of the national program that regulates mercury emissions from existing and future sources is very important in addressing the overwhelming contribution by sources from outside of Minnesota to the Minnesota environment (e.g., Minnesota water bodies). A federal mercury emissions program would minimize competitive disadvantage that regulations on the state levels potentially could create. Coordinated and joint efforts between the state agencies and the EPA would strengthen existing laws and reduce environmental loads of mercury.

Energy Recommendation 24: Continue state enforcement programs to reduce mercury loads



The MPCA should be provided with adequate resources to continue to enforce/support existing mercury regulations and programs that lead to reduced emissions of mercury in Minnesota through market restrictions, pollution control techniques, and disposal requirements.

Description of recommended action. Existing regulations reduce product-sector emissions. The MPCA works closely with and provides education to the industry sectors on mercury reduction strategies and new control technologies. The voluntary/enforcement programs have been successful in reducing mercury air and water emissions.

Energy Recommendation 25: Develop public education on actions that individuals and communities can take to reduce mercury loads



Minnesota should develop a strong public education and outreach effort focusing on the health risks associated with mercury pollution and on techniques for reducing mercury loads (including energy conservation and proper disposal of light bulbs) in the environment.

Description of recommended action. Currently there are a number of state-sponsored and community-based public education and outreach programs addressing mercury emissions. They are specific to certain industries (e.g., energy producing facilities), activities (e.g., disposal of light bulbs) or public health advisories (e.g., mercury fish concentrations). Although beneficial, the programs are often inaccessible by many Minnesota citizens because they are not greatly publicized. Creation of a single, large, well-coordinated interagency public-outreach and education program could potentially address many issues more effectively and efficiently. Promotion and recognition of a single program may be easier to achieve.