2007 PROJECTS

MN Laws 2007, Chapter 30, Section 2 (beginning July 1, 2007)

NOTE: For all projects, contact us to obtain the most up-to-date work programs for current projects (project updates are required twice each year) or the final reports of completed projects.

The following documents are short abstracts for projects funded during the 2007 Legislative Session. The final date of completion for these projects is listed at the end of the abstract. When available, we have provided links to a projects web site. The sites linked to this page are not created, maintained, or endorsed by the LCCMR office or the Minnesota Legislature.

Subd. 3 LCCMR and Contract Administration

3a Legislative-Citizen Commission on Minnesota Resources
3b Contract Administration

Subd. 4 Land

4a Forest Legacy Conservation Easements
4b Minnesota's Habitat Corridors Partnership - Phase IV
4c Metro Conservation Corridors (MeCC) - Phase III
4d Prairie Stewardship Assistance for Private Landowners
4e State Parks and Trails Land Acquisition
4f Metropolitan Regional Park System Land Acquisition
4g Non-Metropolitan Regional Parks and Natural Scenic Area Acquisition
4h LAWCON Federal Reimbursement
4i Biological Control of European Buckthorn and Garlic Mustard - **RESEARCH**
4j Neutralization of Reed Canary Grass Rood Exudates - **RESEARCH**

Subd. 5 Water Resources

5a Local Water Management Matching Challenge Grants
5b Protection of Rare and Unique Rock Outcrop Wetlands
5c Land Retirement Effects on Minnesota River Basin Streams - **RESEARCH**
5d Demonstrating Benefits of Conservation Grasslands on Water Quality - **RESEARCH**
5e Improved River Quality Monitoring Using Airborne Remote Sensing - **RESEARCH**
5f Evaluating Riparian Timber Harvesting Guidelines: Phase 3 - **RESEARCH**
5g Innovative Springshed Mapping for Trout Stream Management - **RESEARCH**
5h Intra-Lake Zoning to Protect Sensitive Lakeshore Areas
5i Water Resource Sustainability - **RESEARCH**
5j County Geologic Atlas Program Acceleration
5k Minnesota's Water Resources: Impacts of Climate Change - Phase II - **RESEARCH**
5l Pharmaceutical and Microbiological Pollution - **RESEARCH**
5m Threat of Emerging Contaminants to Upper Mississippi Walleye - **RESEARCH**
5n Cedar Creek Groundwater Project using Prairie Biofuel Buffers
5o Pyrolysis Pilot Project

Subd. 6 Natural Resource Information

6a Minnesota County Biological Survey
6b Soil Surveys
6c Field Guide for Evaluating Vegetation of Restored Wetlands
6d For Analysis and Implementation of Critical State Natural Resource Data Collection and Mapping

Subd. 7 Establishment of an Emerging Issues Account

Funding Sources: (**note: all projects are TF, unless otherwise noted)
Environment and Natural Resources Trust Fund (TF)
State Land and Water Conservation Account (LAWCON)

Subd. 3 Administration

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Legislative-Citizen Commission on Minnesota Resources
Subd. 3a $1,278,000

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This funding provides for two years of the administration of the LCCMR, its project proposal and recommendation process, and the contract management and project reporting of Trust Fund funded projects. Since 1963, the program that LCCMR is a legacy of has played a foundational role in the appropriation of over $550 million to more than 1,250 projects directly benefiting Minnesota's environment and natural resources.

Project completed: 6/30/2009

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Contract Administration
Subd. 3b $40,000

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For agency Contract Administration
This funding provides for one year of the monetary administration and accounting of Trust Fund appropriations to projects by non-state entities.

Project completed: 6/30/2009

Subd. 4 Land

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Forest Legacy Conservation Easements
Subd. 4a $2,000,000

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Overall Project Outcome and Results
The Blufflands landscape of southeastern Minnesota has been identified by the Department of Natural Resources as an important area for conservation. The mix of forest, bluff prairies, and rivers provides habitat for numerous rare and declining

species as well as many common species, and the oak forests are an important source of hardwood logs for area sawmills. Conserving and protecting large blocks of priority forest habitat through working forest conservation easements is a cost effective method to protect forests in an area where nearly 90% of the land is in private ownership.

The goal of this project was to identify and protect the highest priority parcels with working forest conservation easements. All applications were reviewed and ranked according to program ranking criteria (project size, location, forest quality, adjacency to public land, etc). Five applicants from a group of seventeen applicants were selected and appraisals were completed and certified during 2009 and 2010.

Two projects were completed and closed in December 2009, two in June 2010 and the final project closed in October 2010. A total of 1911.61 acres of private forestland and associated habitats in southeastern Minnesota were protected at an average cost of about $1,055/acre. Total funds expended were $2,017,454.4 and includes $1,975,724 from the Environment and Natural Resources Trust Fund and $41,730.4 from Capital Bonding.

The easements will be held by the State of Minnesota, Department of Natural Resources and monitored on a regular basis beginning in 2011.

These five projects are strategically located or nearby other publicly protected lands and these acquisitions help maintain larger blocks of deciduous forest adjacent or nearby public forests and buffer the publicly owned forest land and provide habitat linkages between publicly owned lands. They also contain productive forest resources of predominantly native forest species that have not been subject to any extensive development and which provide valuable habitat for a diversity of wildlife species.

Project Results Use and Dissemination
Project information will be reported in the Forest Legacy Information System for projects used to provide matching funds for the Koochiching Forest Legacy Project which was completed during this Project period. Project information has been used in a recent StarTribune graphic included in a December 15, 2010 article on the forest legacy program accomplishments.

Minimum Standards and Guidelines for State Forest Legacy Easements in Minnesota (pdf file)

FINAL REPORT

Project completed: 6/30/2010

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Minnesota's Habitat Corridors Partnership - Phase IV
Subd. 4b $4,200,000

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Overall Project Outcome and Results:
Between 7/1/07 and 6/30/09, Minnesota's Habitat Conservation Partnership (HCP) restored, enhanced or protected a total of 32,334 in defined project areas using $16,011,693. This consisted of 17,650 acres with $4,121,730 from the Environment and Natural Resources Trust Fund (ENRTF) and 14,684 acres with $11,889,963 in leveraged funds. See the Final Report posted below or go to http://www.mnhabitatcorridors.org for complete information.

Partners restored/enhanced a total of 27,556 acres (16,788 acres ENRTF; 10,768 acres Other Funds) at a cost of $3,460,895 ($1,180,184 ENRTF, $2,280,711 Other Funds). Total acres exceeded the proposed HCP-Phase IV goal of 6,398 acres due to increased non-state funding being spent upon easement restoration projects during the grant period. Work included 14,610 acres of grassland restoration/enhancement, 7,547 acres of wetland restoration, 91 acres of woodland restoration, 1,040 acres of wetland enhancement, 496 acres of dam modification, 115 acres of shoreline restoration, and 29 acres of wild rice restoration. Other accomplishments included shallow lake surveys, lake aeration, site access/development, and lakescaping demonstration projects/workshops.

Partners acquired a total 3,926 acres (375 acres ENRTF; 3,551 acres Other Funds) of perpetual conservation easements at a cost of $9,448,237 ($910,784 ENTF, $8,537,453 Other Funds). HCP fell shy of the proposed HCP-Phase IV goal of 4,320

acres due to increased nonstate funds being used for habitat restoration activities on easements. Shoreline habitats continued to be a priority for HCP partners working on easement, with over 8.6 shoreline miles protected. Habitats protected were grasslands, wetlands, and woodlands.

Partners acquired a total of 852 acres (487 acres ENRTF; 365 acres Other Funds) in fee-title at a cost of $2,931,662 ($1,857,8078 ENTF, $1,063,800 Other Funds). HCP fell short of the proposed HCP-Phase IV goal of 1,254 acres due to land prices being high, the focus on shoreline (higher priced lands), and other fund projects falling through. HCP achieved 408 acres of new Wildlife Management Areas (WMA), 136 acres of Aquatic Management Areas (AMA), 78 acres of Wildlife Production Areas (WPA), and 230 acres of private/local government lands.

HCP Partners included: Ducks Unlimited; Fond du Lac Reservation; Leech Lake Band of Ojibwe; MN Deer Hunters Association; MN Department of Natural Resources; MN Land Trust; MN Valley National Wildlife Refuge Trust, Inc; National Wild Turkey Federation; Pheasants Forever; The Nature Conservancy; Trust for Public Land; U.S. Fish and Wildlife Service; U.S. Natural Resources Conservation Service.

COMPLETE OVERALL FINAL REPORT

Abstracts and Reports of Individual Partner Projects - available online at: http://www.lccmr.leg.mn/all_projects/2007_projects.html#20074b

- 0x Overall Summary of HCP - Phase IV
- 1a Project Coordination and Mapping (Pheasants Forever)
- 1b Restorable Wetlands Inventory (Ducks Unlimited)
- 2a Hides for Habitat Restoration (Minnesota Deer Hunter Association)
- 2b Partners for Fish and Wildlife (U.S. Fish and Wildlife Service)
- 2c Living Lakes Enhancement (Ducks Unlimited)
- 2d Shallow Lakes Assessment and Management (DNR)
- 2e2 Shallow Lake Impoundment and Management (Leech Lake Band of Ojibwe)
- 2e3 Wild Rice Habitat Restoration (Fon du Lac Band of Chippewa)
- 2g Wildlife Areas Management (DNR)
- 2h Fish Habitat Restoration (DNR)
- 2i Set out Seedlings (National Wild Turkey Federation)
- 2j Lakescaping (DNR)
- 2k Prairie Management (DNR)
- 2n Campaign for Conservation - Restoration (The Nature Conservancy)
- 2o Working Lands Initiative (U.S. Fish and Wildlife Service)
- 3a Shorelands Protection Program (Minnesota Land Trust)
- 3c Shallow Lakes Easements (Ducks Unlimited)
- 3d Wetlands Reserve Program (Ducks Unlimited and U.S. Natural Resources Conservation Service)
- 3f Habitat Encroachment Buffers (Pheasants Forever)
- 3g Campaign for Conservation (The Nature Conservancy)
- 4a Critical Lands Conservation Initiative IV (Pheasants Forever)
- 4b Fisheries Acquisition (DNR)
- 4c Critical Lands Protection Program (Trust for Public Land)
- 4f Minnesota NWTF Super Fund (National Wild Turkey Federation)
- 4g Campaign for Conservation - Acquisition (Nature Conservancy)
- 4h Minnesota Valley Refuge Expansion (Minnesota Valley National Wildlife Refuge Trust)
- 4i Habitat Acquisition - Professional Services (DNR)

Project completed: 06/30/2009

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Metro Conservation Corridors (MeCC) - Phase III
Subd. 4c $2,500,000

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Overall Project Outcome and Results:
During the third phase of the Metro Corridors project, the Metro Conservation Corridors Partners continued their work to accelerate protection and restoration of remaining high-quality natural lands in the greater Twin Cities Metropolitan Area by strategically coordinating and focusing conservation efforts within a connected and scientifically-identified network of critical lands. This corridor network stretches from the area's urban core to its rural perimeter, including portions of 16 counties. The Partners employed a multi-faceted approach, which included accomplishments in four specific result areas:

1. Coordinate Metro Conservation Corridors and Metro Greenways Programs: Partners met quarterly to review project accomplishments and coordinate activity. With DNR support, the partners also launched development of an online database to facilitate tracking and reporting of MeCC projects over time.
2. Restore and Enhance Significant Habitat: Collectively, the partners restored 770 acres of land, including 1.26 miles of shoreline. Restoration of an additional 259 acres was completed using other funds.
3. Acquire Significant Habitat: Collectively, the partners protected 721 acres of land, including more than one-half mile of shoreline through acquisition of fee title and conservation easements and leveraged an additional 232 acres of land and 1/4-mile of shoreline using other funds.
4. Provide Community Conservation Assistance: The Metro Greenways Program assisted four cities and two counties with the integration of natural resources information into local development and conservation planning and policy decisions.

Accomplishments during this phase also helped address a number of recommendations of the Statewide Conservation and Preservation Plan, including: protecting priority land habitats; protecting critical shorelands of streams and lakes; restoring land, wetlands, and wetland-associated watersheds; and improving connectivity and access to outdoor recreation.

Project Results Use and Dissemination
As projects were completed, the individual partners were encouraged to publicize accomplishments through press releases, organization newsletters, and websites. These efforts resulted in information being distributed to the public through websites, email lists, daily and weekly newspapers, newsletters, and other print materials. Additionally, once the MeCC database development is complete, the partnership hopes to be able to better disseminate information on its accomplishments through a public web portal.

COMPLETE OVERALL FINAL REPORT

Abstracts and Reports of Individual Partner Projects - available online at: http://www.lccmr.leg.mn/all_projects/2007_projects.html#20074c

1.1 Overall Summary and Coordination (DNR)
2.1 Restore/Enhance Significant Watershed Habitat (Friends of the Mississippi River)
2.2 Lower Minnesota River Watershed Restoration & Enhancement Project (Friends of Minnesota Valley)
2.3 Restore and Enhance Significant Habitat (Great River Greening)
2.4 Habitat Restoration and Enhancement Grants (DNR)
2.5 Scientific and Natural Area (SNA) Restoration and Enhancement (DNR)
2.6 Stream Habitat Restoration (Trout Unlimited)
3.1 Critical Lands Protection Program - Fee Title & Conservation Easement Acquisition (Trust for Public Land)
3.2 Protecting Significant Habitat by Acquiring Conservation Easements (Minnesota Land Trust)
3.3 Fee Acquisition for Minnesota Valley National Wildlife Refuge (Minnesota Valley National Wildlife Refuge Trust)
3.4 Grants and Acquisition of Fee Title & Conservation Easements (DNR)
3.5 DNR Fish and Wildlife Acquisition (DNR)
3.6 Acquisition of Significant Habitat (DNR)
4.1 Assist Local Governments to Promote Conservation of Natural Habitats (DNR)

Project completed: 06/30/2009

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Prairie Stewardship Assistance for Private Landowners
Subd. 4d $220,000

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Overall Project Outcome and Results
This project provided voluntary, long-range conservation planning and management assistance to private landowners with native prairie. Native prairie is Minnesota's most threatened natural habitat. Less than 1% of the state's native prairie survives - and most of this is on private land. This project provided native prairie landowners with stewardship plans that inventoried and evaluated native prairie and other land resources on their property, identified the landowner's goals and objectives, and recommended ecologically sound management strategies. A total of 25 Prairie Stewardship Plans were created with this project's funds. Landowners were also given an opportunity to participate in 3 different workshops and field days where they could learn more about appreciating and managing their prairies. Furthermore, this project helped landowners with existing stewardship plans to implement their plans by providing cost-share assistance for management practices. Examples of practices cost-shared include prescribed burning (349 acre completed), invasive species treatments (65 acres completed), prairie reconstruction (33 acres completed), and woody encroachment removal (273 acres completed).

Project Results Use and Dissemination
Copies of Stewardship Plans are provided to local DNR managers and used by the landowner with other agencies and programs.

FINAL REPORT

Project completed: 6/30/2009

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State Parks and Trails Land Acquisition
Subd. 4e $1,500,000

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Trails - http://www.dnr.state.mn.us/state_trails/index.html

Overall Project Outcome and Results
Environment and Natural Resources Trust Fund funding allowed for the following State Parks and State Trails fee title land acquisition projects:

- Ownership of approximately 48 acres within the statutory boundary of William O'Brien State Park. Acquisition of this the land eliminated the potential for development on this parcel and its associated impacts to the park, and buffered the park from existing residential development in the area. This parcel added to the existing 1,580 acres already protected within William O'Brien State Park within a Metro Wildlife Corridors Project Area that follows the St. Croix River valley. Preservation of this upland parcel protects the water quality of the adjacent wetlands and sub-watershed leading to the St. Croix River. This parcel provides a route for the proposed Gateway State Trail extension.
- Ownership of approximately 87 acres within the statutory boundary of Frontenac State Park. This parcel consists of primarily wetlands adjacent to Wells Creek delta, a significant migratory waterfowl stopover. The property also includes about 400 feet of shoreline on Lake Pepin and supports many "species of concern" identified in the County Biological Survey. The site is also surrounded by park ownership and is located within a Metro Wildlife Corridors Project Area.
- Ownership of 360 acres within the statutory boundary of George Crosby Manitou State Park. Acquisition of this parcel provided protection to one of the largest and highest quality old-growth northern hardwood forest complexes in the Lake Superior Highlands.
- Ownership of approximately 175 acres along the authorized Casey Jones State Trail corridor. Acquisition of this property secured a location for the future development of approximately one mile of trail corridor for the Casey Jones State Trail along Plum Creek, between Lake Shetek State Park and the community of Walnut Grove.

All acquisitions were from willing sellers, within the statutory boundaries of state parks and for statutory authorized state trails as determined by the Commissioner.

FINAL REPORT

Project completed: 6/30/2010

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Metropolitan Regional Park System Land Acquisition
Subd. 4f $2,500,000

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Overall Project Outcome and Results:
This appropriation leveraged a total of $18.1 million of other funds to acquire 528 acres for the Metropolitan Regional Park System as follows:

- 61 acres on the southern shore of Cedar Lake for Cedar Lake Farm Regional Park in Scott County ($600,000 Environment Trust Funds, $400,000 Metro Council bonds and $3,526,192 of Scott County funds for a total of $4,526,192).
- 8.2 acres including shoreline on the Mississippi River for Grey Cloud Island Regional Park in Washington County ($109,256 Environment Trust Funds, $72,838 Metro Council bonds, and $273,141 Washington County funds for a total of $455,235).
- 3 acres including shoreline on Lake Waconia for Lake Waconia Regional Park in Carver County ($600,000 Environment Trust Funds, $400,000 Metro Council bonds and $1,530,000 Carver County funds for a total of $2,530,000).
- 456 acres which encompasses the entire park for Empire Wetlands Regional Park in Dakota County ($1,020,000 Environment Trust Funds, $680,000 Metro Council bonds, $800,000 other Metro Council grant approved in 2006, $6 million of 2006 State bonds, $3,444,000 of Dakota County funds for a total of $11,940,000).
- 47 acres including shoreline of St. Catherines Lake for Doyle-Kennefick Regional Park in Scott County ($170,744 Environment Trust Funds, $677,625 Metro Council bonds and $282,789 of FY 2009 Metro Greenways Grant for a total of $1,1131,158).

Project Results Use and Dissemination:
Each regional park agency that received a grant or grants from this appropriation informs the public about the land acquisitionwith its own website and news releases. The Metropolitan Council also publishes a "Regional Parks Directory and Map" that informs the public about the recreation activities available at each regional park and trail and includes website addresses and phone numbers for each park agency for more information. Finally, the Metropolitan Council's website includes an interactive parks map that contains the same information as the paper version of the "Regional Parks Directory and Map" at http://www.metrocouncil.org/parks/r-pk-map.htm

FINAL REPORT

Project completed: 10/22/2008

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Non-Metropolitan Regional Parks and Natural and Scenic Area Acquisition
Subd. 4g $1,000,000

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Overall Project Outcome and Results
These programs provide competitive state matching grants to help and encourage local governments to acquire non-metropolitan regional parks and natural areas to meet current and future needs. For the regional park project, every $3 of state grants was matched with $2 of local funds. For the natural and scenic area projects, every dollar of state grants was matched by a dollar of local funds. Three acquisition grants were completed: one Regional Park Grant and two Natural And Scenic Area Grant. The total acreage acquired through all three projects was 310 acres. Approximately one mile of lake

shore line was protected.

Regional Park Grant: One Regional Park Grant totaling $548,000 was made to Stearns County for the acquisition of 265 acres for a new regional park on Kraemer Lake near St. Joseph. Acquisition of this land provides the only publicly owned access to the lake. Much of the property was identified by the County Biological Survey as a significant native plant community. This land, part of the Avon Hills area, was acquired by the county in November, 2007.

Scenic and Natural Area Grant: Two grants were made for natural and scenic areas. In November 2007 the City of Prior Lake acquired 30 acres on Pike Lake for a new city park and natural area with a state grant of $230,000. This acquisition protects one of the largest remaining areas of undeveloped shoreline in the city. In 2008 the City of Red Wing acquired 15 acres for an addition to an existing 72 acre Bluff Land Conservation Area with a state grant of $156,000.

The remaining $66,000 covered DNR administrative/personnel costs for the program.

Project Results, Use and Dissemination
Profiles and photos of these projects are available on the DNR web site at www.mndnr.gov. Click on "Grants" and then "Land Conservation" to find the links to the Regional Park Grants and Natural and Scenic Areas programs. Click on "Park Profiles" or "Project Profiles". Then go to the individual project profiles for a photo of the site, brief summary and links to local web pages.

FINAL REPORT

Project completed: 6/30/2009

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LAWCON Federal Reimbursement
Subd 4h $500,000

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Overall Project Outcome and Results
The appropriation was used to pay for the state's administration of the Land and Water Conservation (LAWCON) program. This included administration of annual LAWCON grant solicitations for local projects, all grant management activities related to funded projects, all federal reporting requirements, management of funds used for state projects, management of several conversions of previously funded projects, and all monitoring and inspection activities required as a condition of acceptance of the federal funds. In addition, $125,000 was used to fund purchase of picnic tables and fire rings/grates, most of which are accessible, for several state parks as follows:

State Park	Total # Tables	Accessible Table	Fire Rings*
Crow Wing	25	25	15
Father Hennepin	0	0	9
Fort Snelling	10	10	6
Frontenac	25	6	15
Maplewood	53	9	34
McCarthy Beach	25	8	15
Sibley	0	0	31
Upper Sioux Agency	25	25	15
Wild River	25	10	15
Afton	4	2	4
Total =	**192**	**95**	**159**

* All fire rings are accessible.

This project was consistent with action priorities outlined in the state's 2008-2012 State Comprehensive Outdoor Recreation Plan (SCORP) including:

- "Maintain and adequately fund current infrastructure, including improvements for safety, accessibility and energy efficiency."

- "Identify and address barriers to outdoor recreation, including economic issues, facility design, public awareness, and safety and security concerns."

Project Results Use and Dissemination
See chart above for location of funded tables and fire rings.

FINAL REPORT

Project completed: 6/30/2010

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Biological Control of European Buckthorn and Garlic Mustard
Subd. 4i $300,000

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RESEARCH

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Overall Project Outcome and Results
Garlic mustard (Alliaria petiolata) and European/common buckthorn (Rhamnus cathartica) are non-native invasive plants that severely threaten native plant communities and degrade wildlife habitat. This project focused on development of biological control as a long-term management strategy for these species. Reports describing the garlic mustard and buckthorn research in detail are attached to the project's Final Report. Garlic mustard biocontrol agents have not yet been approved for release in the US. Garlic mustard research focused on monitoring the 12 field sites for pre-release research. Garlic mustard monitoring data from 2005 to 2009 showed that garlic mustard populations can vary considerably from year to year. Garlic mustard plants are occurring at high population densities (mean densities up to 133 adult plants/m2 and 720 seedlings/m2) and are currently experiencing very little herbivore attack in Minnesota. Work will continue on monitoring the field sites, developing rearing methods, and conducting field releases once insects are available. Buckthorn biocontrol research carried out in 2007-09 concentrated on a leaf-feeding moth, a leaf-margin gall psyllid, and a seed-feeding midge as potential biocontrol agents. The moth was found to lack enough host-specificity and was eliminated from consideration as a biocontrol agent. Host-specificity testing will continue for the leaf gall psyllid as larvae did not develop on the North American Rhamnus species tested. One complication is that the phytoplasma 'Candidatus Phytoplasma rhamni' has been detected in the leaf gall psyllid. Future work will explore the implications of this phytoplasma for using the leaf-gall psyllid as a biocontrol agent. Initial success in rearing a population of the seed-feed midge will allow for future host-specificity testing of this insect. Future work will concentrate on 3 promising potential biocontrol agents, 2 psyllids, and the midge.

Project Results Use and Dissemination
The results of the garlic mustard and buckthorn research projects have been shared widely. Updates on the garlic mustard monitoring and biocontrol research and buckthorn biocontrol research were presented at the Minnesota Invasive Species Conference (Oct. 26-29, 2008, Duluth MN) and the upcoming Minnesota-Wisconsin Invasive Species Conference (Nov. 8-10, 2010, St. Paul, MN). In addition, results have been shared across the state through such venues as County Agriculture Inspector meetings, DNR meetings, and Master Gardener meetings. There is considerable interest in these programs and enthusiasm for the potential for biological control of garlic mustard and buckthorn. The results of the garlic mustard monitoring research were reported in the article "Population Biology of garlic mustard (Alliaria petiolata) in Minnesota hardwood forests" by L. Van Riper, R. Becker, and L. Skinner in 2010 in the journal Invasive Plant Science and Management (3:48-59). Results of the buckthorn research were reported in the article "Use of native range surveys to determine the potential host range of arthropod herbivores for biological control of two related weed species, Rhamnus cathartica and Frangula alnus" by A. Gassmann, I. Tosevski, and L. Skinner in 2008 in the journal Biological Control (45:11-20).

Project Publications:

1. Biological control of backthorns, *Rhamus catartica* and *Frangula alnus* - Report 2008-2009
2. Monitoring garlic mustard (*Alliaria petiolata*) in anticipation of future biocontrol release (2005-2009)

FINAL REPORT

Project completed: 6/30/2010

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Neutralization of Reed Canary Grass Root Exudates
Subd. 4j $115,000

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RESEARCH

Overall Project Outcome and Results
Reed canary grass (Phalaris arundinaceae; hereafter Pa) is an aggressive plant invading wetlands in the Midwest. Invasion by Pa leads to a reduction of native plant diversity and loss of wetland functionality. Our ability to control invasion by Pa and reestablish native plant communities has been unsuccessful because of our limited understanding of the mechanisms that allow Pa to become invasive. The study of plant-soil feedbacks as a mechanism for dominance is a two-step process: plants alter their soil microbial community; and the altered soil microbial community has a positive feedback on plant growth or a negative feedback on neighboring plants. Results from three experiments comparing soil microbial communities and plant growth revealed that Phalaris arundinacea (Pa) used plant-soil feedbacks to outcompete tussock sedge (Carex stricta; hereafter Cs).

In a soil training experiment, Pa and Cs cultured their soil microbial communities in a manner that differed in both magnitude and composition. Soil training had a neutral feedback on Pa growth and a negative feedback on Cs.

In our first reciprocal transplant experiment, growth of Pa and Cs was greater in their corresponding native soils than in the soil of the other species. Thus, both plants receive positive feedback from their native soil microbial communities. Soil microbial communities were similar when cultivated by Pa regardless of soil type, and Cs soil microbial community catabolic activity depended on soil type.

In our second reciprocal transplant experiment, the effects of competition were dependent on soil microbial communities. Pa growth was best in competition with Cs in Cs-native soils and Pa-sterile soils. Competition did not affect the growth of Cs; however, Cs growth was least in native soils from Pa and Cs. In sterile soils, soil microbial communities depended on the type of competition. In native Pa soils, heterospecific competition had a greater effect on soil microbial communities than did conspecific competition.

Denaturing gradient gel electrophoresis (DGGE) analysis indicated that Pa SMCs were stable and of low diversity, but Cs SMCs were dynamic and of comparatively high diversity.

Bioassays and gas chromatography-mass spectrometry (GC-MS) analyses revealed the presence of methyl esters of fatty acids known to have antimicrobial activity.

Our results suggest that Pa does not use alleopathy, but is induced to produce an antimicrobial compound that has a strong, directional effect on soil microbial communities, which promotes its growth and inhibits the growth of neighboring plants.

Project Results Use and Dissemination Portions of Results 1, 2, and 3 have been written as a manuscript (A plant-soil feedback as a mechanism for the invasive success of Phalaris arundinacea) and is being revised for publication. A second manuscript including Results 1-5 is in preparation by the investigators. Portions of this work were presented:

1. As an invited talk at the University of Bern, Switzerland (8/08)
2. At the 93rd Annual Ecological Society of America Meeting; Milwaukee, WI. (8/08)
3. At the 13th Annual Conference of the Wisconsin Wetland Association; Oconomowoc, WI. (2/08)
4. Two papers at the North American Lake Managers Society (NALMS) International Conference; Hartford, CT. (10/09)
5. Four papers at the 2008 and 2009 Minnesota State University Undergraduate Research Conference (4/08 and 4/09)

In addition, portions of this work were used for a M.S. thesis project, as class exercises in undergraduate courses, and as several undergraduate independent research projects at Minnesota State University.

FINAL REPORT

Project completed: 6/30/2009

Subd. 5 Water Resources

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Local Water Management Matching Challenge Grants
Subd. 5a $350,000

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Overall Project Outcome and Results
Grants were awarded to 4 counties, 5 soil and water conservation districts, 2 water management organizations, and 1 joint powers board for the purpose of implementing high priority actions identified in current state approved and locally adopted comprehensive water management plans. The funds were used to complete the following projects:

- Prevented agricultural tile flows from discharging to surface waters and monitored nitrate concentrations of these flows in the Nile Mile Creek watershed.
- Protected nearly 900 acres of land adjacent to lakes and streams in Cass and Aitkin Counties.
- Implemented 10 grazing plans to reduce fecal coliform loading to the Root River.
- Generated watershed delineations and lake volume calculations that contributed to the adoption of development restrictions on 44 lakes in Itasca County.
- Completed preparations that ultimately will stabilize a streambank to protect a cemetery in Hallock from a slumping streambank.
- Designed and stabilized a 2-mile segment of a judicial ditch in the Bostic Creek watershed of Lake of the Woods County.
- Demonstrated that straw bales result in decreased phosphorus concentrations in ditch flows to Lake Volney in Le Sueur County.
- Installed a grade stabilization structure in a gully to prevent the deposit of sediment into the St. Croix River.
- Restored shoreland along Mille Lacs Lake in Mille Lacs County.
- Reduced the discharge of stormwater from the City of Wadena.
- Tested the quality of water in the Mt. Simon Aquifer and sealed three wells in Washington County.

Project Results Use and Dissemination
Results of the specific projects are available upon request from the Board of Water and Soil Resources.

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Project completed: 6/30/2010

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Protection of Rare and Unique Rock Outcrop Wetlands
Subd. 5b $563,000

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Overall Project Outcome and Results
The Minnesota River Valley contains ancient bedrock outcrops with associated wetlands that provide unique habitats for specialized plant and animal communities rarely found elsewhere in Minnesota. These resources are threatened by mining and other development interests, as removal of the rock results in the severe degradation or permanent loss of the wetlands located among the rock complexes. Although the wetlands vary greatly in size and duration, some of the smallest and most temporary basins harbor the rarest and most specialized plants. Many of these wetlands may not be protected due to de minimis (i.e. minimum size) exceptions to the Wetland Conservation Act. Rock outcrops are also a component of the Minnesota River's riparian zone and destruction of this unique habitat will continue to degrade the water quality and aquatic habitat of the Minnesota River and its tributaries. Unlike other mining operations, there is no reclamation plan possible for replacing this very unique landscape feature once it is removed. This project consisted of efforts to protect these unique habitats through conservation easements and habitat restoration activities.

For the conservation easements portion of the project, applications from 9 landowners totaling 788 acres were scored by a team of natural resource professionals to determine the highest quality sites under grant guidelines. The goal of this project was to protect 200 acres with Reinvest in Minnesota (RIM) perpetual conservation easements in Renville and Redwood Counties. That goal was exceeded and 212.4 acres were protected. Four landowners received $517,411 in easement payments from grant funds. In accordance with the RIM program, landowners retain ownership.

For the habitat restoration portion of the project, $16,049 in grant funds were used for invasive species control, along with $31,441 leveraged from other sources to assist in meeting the goals of the conservation plans developed on each easement as part of the RIM process.

Project partners were USDA NRCS, MN DNR Wildlife (Heritage Enhancement), DNR ECO-Non Game (Heritage Enhancement), State of Minnesota Native Buffer Cost Share Program, and US Fish & Wildlife Service.

Project Results Use and Dissemination
Initially staff from the Renville & Redwood Soil & Water Conservation Districts (SWCD) had face-to-face contact with landowners. This proved to be a very successful way of generating applications, as 788 acres were offered. The applications that were not funded were kept for future reference and landowners have all been contacted and given an opportunity to apply for dollars from the ML 2009 Environment and Natural Resources Trust Fund appropriation for $1.5 million, for which we have a goal of enrolling an additional 530 acres in perpetual easements.

Several newspaper articles have been published since the inception of the 2007 grant. The regional West Central Tribune in Willmar, MN has done articles about the program. In addition local newspapers have included articles about the program. Tom Kalahar, Project Manager, was interviewed by Fred Harris for an article published in the March-April 2009 issue of the Minnesota Conservation Volunteer. The early articles caused landowners in other counties to request information on how they could enroll their land into the program. This landowner interest resulted in Chippewa, Yellow Medicine and Lac qui Parle SWCD offices joining Renville & Redwood in making application for the 2009 funds.

The Renville SWCD continues to update the public on the status of the grants on their website www.renvilleswcd.com Tom Kalahar has done informational/educational talks on the Minnesota River Basin and the unique features of the Granite Rock Outcrops. Audiences included the general public in both Redwood Falls and New Ulm, a presentation for landowners in the Renville/Chippewa DNR Working Lands Initiative area, as well as a presentation to the Upper Sioux Community. DNR Private Lands Program staff have used their one-on-one contacts with landowners to promote the program in addition to sponsoring the Landowner Workshop which included Tom's presentation on the Rock Outcrop program.

In August 2008, Renville SWCD hosted the Board of Water & Soil Resources (BWSR) meeting. A one day tour for about 60 people included stopping at a rock outcrop site. SWCD staff used this opportunity to inform the BWSR and guests about the uniqueness of the natural resource and to give them an update on progress toward meeting the goals for the grant.

Local SWCD staff and supervisors continue to keep their local County Boards informed about progress of not only the 2007 grant but also about landowner interest for future funding.

FINAL REPORT

Project completed: 6/30/2009

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Land Retirement Effects on Minnesota River Basin Streams
Subd. 5c $275,000

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RESEARCH

Overall Project Outcome and Results
The Minnesota River Basin lies within one of the most productive and intensively managed agricultural regions in the world. Current agricultural practices use large quantities of chemical fertilizer to maintain productivity - as much as 7.4 and 2.9 tons/mi2 for nitrogen and phosphorus, respectively. The excess of these nutrients have the potential for deleterious effects on stream quality through runoff. To address concerns about degradation of agricultural streams, the state of Minnesota was requested to provide funding to retire an additional 100,000 acres of agricultural lands to improve water quality and aquatic biology. This study was designed to provide a comprehensive evaluation of agricultural set-aside programs on a basin scale and their effect on water quality.

This study was divided into two phases. The primary Phase 1 objective was to compare water quality and aquatic biological conditions across three basins similar with respect to physical setting and hydrology, but differing in the degree of agricultural land retirement. The Phase 2 objective was to assess the relation between biotic integrity and land retirement across the Minnesota River Basin.

Fully-instrumented sampling sites with automated samplers, water-quality monitors, and streamflow gages were installed from 2005-2008. Findings include:

- Nitrogen concentrations were highest, with a mean of 15.0 mg/L, in South Branch Rush River, the subbasin with little land retirement; nitrogen concentrations were lower in Chetomba Creek (mean of 10.6 mg/L) and West Fork Beaver Creek (mean of 7.9 mg/L), subbasins with more land retirement at the basin scale.
- Total phosphorus concentrations were not directly related to land retirement percentages with average concentrations of 0.259 mg/L at West Fork Beaver Creek, 0.164 mg/L at Chetomba Creek, and 0.180 mg/L at South Branch Rush River.
- Index of biotic integrity (IBI) scores increased as local land retirement percentages (within 50 and 100 meters of the streams) increased.
- Comparisons made within the basins showed that nutrient, suspended-sediment, and chlorophyll-a concentrations decreased with increasing land retirement.

Data from this study can be used to evaluate the success of land retirement programs for improving stream quality. Two reports will be published in September 2009, describing Phase 1 and Phase 2 of the study.

Project Results Use and Dissemination
The results from this study were disseminated through USGS and BWSR websites, two abstracts, a conference proceeding paper, and several presentations and posters. The water-quality and streamflow information was provided in real-time through the USGS website. USGS and BWSR personnel have participated in basin activities highlighting the selected subbasins and emphasizing the effects of land retirement. A USGS Scientific Investigations Report entitled, "Water-Quality and Biological Characteristics and Responses to Agricultural Land Retirement in Streams of the Minnesota River Basin, Water Years 2006-08" is scheduled to be published by September 30, 2009. A manuscript has been completed covering Phase 2 of the study and will be submitted to a peer reviewed journal in September 2009.

FINAL REPORT

Project completed: 6/30/2009

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Demonstrating Benefits of Conservation Grasslands on Water Quality
Subd. 5d $374,000

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RESEARCH

Overall Project Outcome and Results
This study used sediment accumulation rates in 26 lakes in southern and western Minnesota as a measure of the delivery of eroded soil and phosphorus from watershed uplands to the lakes. Accumulation rates were calculated for the periods 1963-1986 and 1986-2007 to characterize sediment and phosphorus delivery before and after 1986, when many agricultural lands were converted to grasslands as part of the Conservation Reserve Program (CRP). Inorganic sediment accumulation rates decreased with increasing area of conservation grassland in the watershed. This linear relation explained only about 20% of the variance, leaving substantial unexplained scatter. The relation predicted that sediment accumulation would decrease by 3-4% for every 10% of cropland converted to grassland. Consideration of wetland sediment traps within the watershed did not measurably improve the relationship, nor did consideration of soil erodibility, slope, or flow accumulation factors. The decrease in sediment phosphorus accumulation rates as a function of increasing grassland area was not statistically significant at the $p = 0.05$ level. Diatom analyses demonstrated biotic change in selected lakes over time. In two of these lakes the change appeared to be driven by lake-water phosphorus concentrations, which declined in the post-1986 period perhaps in response to increased grassland area. In the absence of substantial land-cover change, inorganic sediment accumulation increased by about 20% and sediment phosphorus increased by about 35%, indicating that other factors were influential. These factors could include changes in annual rainfall, artificial drainage, in-lake sediment transport processes, and lag effects in transport from uplands to lowlands.

We conclude that this study demonstrated a fundamental incoherence between field-scale parameters influencing erosion and watershed-scale measurements of erosion. We recognize the fundamental importance of the empirical plot-scale studies that have quantified the effects of erodibility, slope, flow length, land cover, and other factors on erosion and nutrient transport. Yet, the complexities of transport paths between field and receiving waters make watershed-scale erosion highly variable and difficult to predict. Use of plot-scale parameters without modification to predict watershed-scale sediment yields is inappropriate. We need better understanding to re-scale such parameters appropriately, which can only be achieved by intensive studies that bridge the intermediate scales between fields and watersheds. New data sets, especially improved topographic data from LiDAR, will help with this effort. However, nothing can replace the actual measurement of sediment yield at different scales, which will provide the necessary constraints for theoretical equations to give realistic results.

Project Results Use and Dissemination

- An interpretive summary report will be downloadable from the Museum web site.
- A short (2-4 pp.) fact sheet likewise will be downloadable from the Museum web site, with hardcopies made available as requested.
- Results will be published in the academic peer-reviewed literature.

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Project completed: 6/30/2010

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Improved River Quality Monitoring Using Airborne Remote Sensing
Subd. 5e $159,000

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RESEARCH

Overall Project Outcome and Results
To improve the study and monitoring of river water quality and riparian habitat in Minnesota this project proposed and successfully implemented a new and innovative research methodology, airborne dynamic hyperspectral remote sensing (remote sensing measures properties of the environment using sensors placed on aircraft or spacecraft). This study has more accurately and cost effectively identified water quality and critical sediment supply areas than possible through traditional or previously used monitoring methods. All methods and results developed here can readily be applied to other

watersheds.

For the first time ever in the USA we employed the highly cost effective Civil Air Patrol (CAP) ARCHER (Airborne Real-time Cueing Hyperspectral Enhanced Reconnaissance) remote sensing system to monitor water quality in a river. In addition to successfully piloting this new methodology in the highly impacted Blue Earth River (BER) watershed, tangible results and products include:

- Located highly erodible lands in the BER riparian corridor.
- ARCHER can successfully identify Total Suspended Sediment, Turbidity and other water quality measures thus potentially reducing time and costs using traditional methods in any watershed.
- Identified locations of high sediment input areas and spatial and temporal patterns of river water quality.
- Developed a hydrologic model to predict amount and location of sediment and stream flow based upon the size and intensity of precipitation events.
- A Geographic Information System database was developed that contains all project data.
- Two full years of detailed water quality data collected from ARCHER flights, traditional field sampling methods and related laboratory analyses. Water samples were collected along the entire river system at the same time as ARCHER flyovers, during spring runoff and during nearly all rainfall events.
- Processed remote sensing imagery and laboratory data from this study is ready for use in future studies and management decisions.

Project Results Use and Dissemination
The results and findings were documented in project updates to the LCCMR, through multiple conference presentations by the project scientists and their graduate students, three Minnesota State University (MSU) Geography Department master's theses, several academic articles, and further professional presentations are in preparation, with some of these items already available on the web. Partnerships established to complete the project include local, county, regional, state and federal agencies and scientists at those agencies and at other universities. Communication and outreach has flourished with the creation of a nation-wide ARCHER working group founded by this project's scientists: members include MSU, and professionals from 13 other state and federal agencies, universities, and the private sector. A meeting of the working group will take place April 2010 at the annual meeting of the Association of American Geographers (AAG) in Washington, DC.

To implement and complete the project we established partnerships with MPCA, Faribault & Martin Co. Soil & Water Conservation Districts, U.S. Army Corps of Engineers, and University of Minnesota. In 2008, we were contacted by USGS and Missouri (Mo) DNR who were interested in knowing more about our projects and findings. Thereafter, we formed an ARCHER working group to "provide a forum for agencies/researchers with on-going or anticipated projects using ARCHER imagery to collaborate, exchange information on promising applications and share analytical techniques" (http://rmgsc.cr.usgs.gov/awg/index.shtml). Besides us, other members include CAP, USGS, USFWS, EPA, FEMA, BLM, MoDNR, MoRAP (Missouri Resource Assessment Partnership), Space Computer Corporation, and other university and industry-based individuals. The working group holds monthly conference calls and exchanges lots of e-mail and phone communications. We have organized special sessions on ARCHER applications in the 2010 national conference of the AAG (Association of American Geographers) in Washington, DC.

Especially noteworthy is our partnership with the CAP (Civil Air Patrol). Based on methodologies we developed specifically for this project to pre-process ARCHER data, the CAP has now adopted our methods and has now supplied the needed software to all 16 ARCHER stations across the country. This is of great significance because of the potential for using ARCHER in environmental monitoring nationwide.

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Project completed: 6/30/2009

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Evaluating Riparian Timber Harvesting Guidelines: Phase 3
Subd. 5f $400,000

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RESEARCH

Overall Project Outcome and Results
This project continues research begun with M.L. 2001 and M.L. 2005 appropriations from the Environment and Natural Resources Trust Fund.

Research addressing the long-term effectiveness of riparian guidelines to mitigate harvesting impacts is critical to resolve management conflicts and sustain Minnesota's forest resources. This project:

1. Evaluated the long-term effectiveness of Minnesota's riparian timber harvesting guidelines within Pokegama Creek (single-basin study) and on eight separate basins located across northern Minnesota (multiple-basin study);
2. Began to combine and synthesize data from the various study components through a "meta-analysis";
3. Provided outreach information.

Terrestrial findings that can help guide future management of Minnesota's forests and streams include:

- Partially-harvested riparian management zone (RMZ) treatments resulted in fully-stocked stands, however, species composition differed among treatments;
- Northern white cedar and balsam fir seedlings survive and grow well in non-wet microsites with medium residual basal area;
- Cedar seedlings require protection from deer browsing;
- Different treatments had minimal impact on the amount of organic matter input to streams;
- Residual tree blowdown was low, but future potential is still high.

Effects of riparian harvest on fish and fish habitat were assessed at the basin scale. Sediment levels remained above 1997 pre-harvest conditions until fall 2007. Riparian harvest may have contributed to increased stream temperatures, but fish abundances were negatively associated with differences in mean summer air temperature.

Aquatic findings that can help guide future management of Minnesota's forests and streams include:

- No differences in water chemistry between harvested and unharvested riparian reaches;
- Trends toward higher in-stream light levels and elevated periphyton standing crops within harvested riparian areas compared to control reaches;
- Trends toward a greater proportion of scraper invertebrates and fewer shredder invertebrates in harvested riparian reaches.

At the single-basin tributary sites, the majority of bird species present were associated with mature forest habitat pre-harvest. After harvest, early successional habitat associated species maintained dominance in all sites. The pre-harvest bird community was neither maintained nor able to reestablish on unharvested riparian buffers 9-11 years after harvest.

We observed interannual variation in diversity and species richness within the macroinvertebrate and fish communities, but few effects related to harvest treatments. Few changes in diversity and richness were observed in the bird community but changes were observed by the replacement of mature forest species by early successional avian species, related closely to the vegetation type.

There is a need to continue monitoring the sites to more fully assess effects over time.

Project Results Use and Dissemination
A workshop entitled "At the Water's Edge: Current State of Riparian Forest Management Research in Minnesota" was presented in Grand Rapids on May 20, 21, and 22, 2008. The purpose of the workshop was to interpret research results from the single- and multiple-basin riparian effectiveness monitoring studies as well as the Minnesota Forest Resource Council's Riparian Science Technical Committee findings for natural resource managers and loggers. The program included both indoor and outdoor components. There were 102 participants over the course of the three days.

A website was developed to provide information about the project, including a project overview, more detailed descriptions of our research, information about project personnel, a listing of project cooperators, project publications, and information presented during our workshop. The url for that website is http://rmzharvest.cfans.umn.edu/. A second website was created to allow project researchers to access data (http://rmzharvest.cfans.umn.edu/login).

Beyond the workshops and website, project results were disseminated to scientists, natural resource managers, private landowners, researchers, and others through nine presentations, one refereed manuscript, and one field tour. Three additional manuscripts are in preparation. One graduate student produced a thesis from their project work. Other graduate students continue to collect, analyze, and summarize data which will result in additional theses. Annual summaries of project results were provided to the Minnesota Forest Resources Council for inclusion in their Annual Report.

As this research study was designed to be a long-term assessment with little dissemination during the initial project phases, researchers will continue to monitor, analyze, and report post-harvest effects in the future as funding permits. With that

additional information, we will be able to assess how birds and terrestrial and aquatic ecosystems respond to timber harvesting within RMZs over the long-term. Results will then be used to inform on-the-ground decision making as well as suggest changes to the guidelines to more effectively manage forested riparian areas.

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Project completed: 6/30/2009

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Innovative Springshed Mapping for Trout Stream Management
Subd. 5g $270,000

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RESEARCH

Overall Project Outcome and Results
Trout streams depend on a steady supply of clean, cold water to exist. The U of M's Geology and Geophysics Dept. and the DNR Waters worked to identify and map the karst springs and their recharge areas that supply water to southeastern Minnesota's 173 trout streams and to assess the impacts that both land and aquatic development are having on these springs.

Delineation of the recharge areas or springsheds of the trout springs is a crucial first step in the protection of the trout fisheries and the restoration of those that have been degraded. Established fluorescent dye tracing techniques were refined, accelerated and expanded into springsheds parts of southeastern Minnesota not previously traced. Traces in Fillmore and Olmsted counties defined new trout stream springsheds and expanded and refined information on previously known trout stream springsheds in the Galena Aquifer. The traces in Winona and Houston Counties began the definition of trout stream springsheds draining the Prairie du Chien Aquifer. Prairie du Chien springs supply water to several major fish hatcheries and trout streams.

Although many of southeastern Minnesota's trout stream are headed by springs flowing from the St. Lawrence Formation, the St. Lawrence has been assumed to be an aquitard in Minnesota Rules. Three successful traces through the St. Lawrence Formation in Winona and Houston Counties demonstrated that water flows rapidly through the St. Lawrence to trout springs. This unexpected discovery is a major advance in our understanding and management of these trout springs and is resulting in a significant reevaluation the hydrogeology of the St. Lawrence Formation.

In addition to dye tracing, four innovative Trout Springshed Assessment protocols were investigated. The first was the use of data logger technology to characterize time variations in the thermal and chemical properties of trout springs. The temperature loggers identified at least four distinct patterns of temperature variations present in trout springs which inturn yield information about the respective springsheds. The second innovative technique was the construction of new, high precision structural contour maps of the geologic strata hosting trout springsheds. This tool looks promising but will require more precise mapping that is currently available. The third innovation was an investigation of the relationship between the size of springsheds and the base flow volume of the trout springs. This technique is promising but requires more well defined springsheds to become a practical tool. The last technique investigated was the measurement of dissolved organic compounds (DOC) in the springs. Significant differences in the amount and composition of the DOCs were observed which may be relatable to varying land uses in the springsheds.

The springsheds defined by the tracing and the other tools allow an accurate documentation of the rapid, direct impact of surface land uses in the springsheds and the water quality in the trout streams. This inturn allows better management of the springsheds to protect the trout streams and groundwater resources.

Project Results Use and Dissemination
The dissemination and use of the results of the trout springsheds delineation has varied depending on the level of the user. At the local level one of the most effective dissemination tools has been to get the landowners and users involved in the research itself. This has included getting Harmony High School students involved in the traces around Harmony, Minnesota.

Getting many of the local residents involved in the tracing. Getting the County staffs, local organizations, the trout fishing community and the trout hatchery staffs involved in the tracing. We send copies of the reports into the hands to the affected landowners and residents involved. All of these people now know the speed at which the surface runoff can reach their trout streams. They are the "first line of defense" in maintaining and improving the water quality in the trout streams.

At the regional and state levels Alexander and Green have made numerous presentations various state water management and ground water meetings. We have led field trips highlighting the results of this project. Contribute the results of this information at a variety of levels inside the Minnesota State Government. The information is built into short courses, training sessions, technical comments and University of Minnesota courses. The discovery that water moves rapidly through the St. Lawrence "aquitard" is already impacting management rules and practices in several State Agencies. The increasingly detailed knowledge of the springsheds is an important part of the TMDL effort to protect and improve water quality in trout streams in southeasten Minnesota.

At the national level the results obtained in this project were presented at the 11th Multidisciplinary Conference on Sinkhole and the Engineering and Environmental Impacts of Karst, at Geological Society of America meetings and published in their Proceedings. National Science Foundation summer interns have participated in the research effort and taken the knowledge and experience back to other states.

PROJECT PUBLICATIONS:

1. Spring Characterization Methods and Springshed Mapping
2. Dye Tracing Within the St. Lawrence Confining Unit in Southeastern Minnesota
3. 2 July 2007 Morehart Farm Dye Trace
4. Frego Creek Dye Trace
5. Harmony Spring 2008 Dye Trace
6. A Quantitative Dye Trace in the Bat River System & Poster
7. Peptidoglycan Degradation Fluorescence: Applications to Karst Groundwater Mapping & Poster
8. Forestville North Dye Trace
9. Sinks and Rises of the South Branch Root River, Fillmore Co., MN
10. Flow Path Characterization using Spring Thermographs
11. Holy Grail Cave, Fillmore County, Minnesota
12. Harmony Fall 2008 Dye Trace
13. Frego Creek Spring 2009 Dye Trace

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Project completed: 6/30/2009
Work Program

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Intra-Lake Zoning to Protect Sensitive Lakeshore Areas
Subd. 5h $110,000

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Overall Project Outcome and Results
Minnesota's lakes are one of its most valuable resources. In particular, naturally vegetated shorelines provide feeding, nesting, and breeding habitat for many species. These areas, defined by natural and biological features that provide unique or critical ecological habitat, are known as sensitive lakeshores. Increasing development pressure within shorelands may have negative impacts on these sensitive areas - and Minnesota's shorelands are being developed at a rapid rate.

With this in mind, the Minnesota Department of Natural Resources developed a protocol for identifying sensitive lakeshores. The project focused on seventeen high priority lakes, identified by Cass County. These lakes represent some of the county's most valuable waters - large lakes with significant undeveloped shorelands. Protocol to identify sensitive lakeshores consists of several components:

- Field surveys evaluate the distribution of high priority plant and animal species.
- An ecological spatial model, based on scientific data, ranks lakeshore areas for sensitive area designation. The model

provides objective, repeatable results that can be used as the basis for regulatory action.

Field surveys were conducted on all seventeen high priority lakes as well as three connecting lakes. Sensitive lakeshore area assessments were completed on nine high priority lakes. Reports summarizing these assessments were delivered to Cass County and interested organizations that could use the information to maintain high quality environmental conditions. To date, 48 miles of shoreline (approximately 36 percent of total surveyed shoreline miles) have been identified as sensitive lakeshore. Cass County is working to develop provisions in their land use ordinance that will require conservation-oriented development standards for sensitive areas. They will then propose and implement resource protection zoning districts. These resource protection districts will help promote healthy near-shore communities and protect critical fish and wildlife habitat.

Project Results Use and Dissemination
Nine Sensitive Lakeshore Reports were produced, and these reports are posted on the project's website. Public presentations were made explaining the project and the details of the sensitive lakeshore reports to the Cass County Board of Commissioners, the Cass County Planning Commission, the Association of Cass County Lake Associations, U.S. Forest Service, seven lake associations, and several interested groups and organizations. Cass County will hold public hearings on shoreland ordinance revisions and reclassifications in an effort to protect identified sensitive lakeshores, and all required processes for public input, review, and comment will be adhered to, including the rights afforded to challenge such ordinance and zoning district changes.

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Project completed: 6/30/2009

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Water Resource Sustainability
Subd. 5i $292,000

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RESEARCH

Overall Project Outcome and Results
To assure that our use of freshwater within Minnesota is sustainable into the indefinite future it is necessary to know beforehand the rate of renewal of our freshwater supplies on an annual basis. The rate of renewal of freshwater supplies is a measure of the limits of the natural system to sustain both human needs as well as the needs of nature (ecological services). This project quantified this rate of renewal across the state and related the rate to various characteristics of the local landscape. This quantification was achieved using streamflow records for gauged watersheds located throughout Minnesota. The final result is in the form of atlases of mean minimum annual groundwater recharge (the rate of annual renewal of the freshwater resource) at three different geographical scales: statewide, regional, and county. Regional atlases were developed for the east central, southeast, and south central regions of the state. County atlases were created for Pope, Lac Qui Parle and Olmsted counties. Based on these atlases and the MNDNR water permits a database was produced that will allow the quantitative comparison of renewable freshwater supply and the water demand for human use down to the scale of individual township sections. The database provides the information needed to assess freshwater sustainability on any desired geographical scale. The atlases and the database supplied by this project will be of value to water planners at all geographical levels. One limitation of the current results provided is that they do not account for changes that occur in time, and therefore do not account for possible effect of future climate change. This aspect is needed to provide additional information to water planners for consideration of the risks posed by climate change.

Project Results Use and Dissemination
To date the project results have been used for an assessment of siting of a gas-fired power plant in Chisago County. In this case John Nieber was requested by 'The Friends of the Sunrise' to speak to their group, and other interested citizens regarding to the availability of groundwater resources for projected use by the power plant. The Minnesota Environmental Quality Board used results from the precursor study in helping to formulate the EQBs 2008 report on water resources sustainability, and it is expected that the results of the current study will be used for similar statewide assessments in the future. Of course it is the hope of the PI and co-PI of the project that the results will be used by the MNDNR, the MPCA,

and by other agencies in conducting water resource planning activities. A website for the project exists at https://wiki.umn.edu/view/Water_Sustainability. Many presentations have been made regarding this project every since the project began in 2007.

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Project completed: 6/30/2009

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County Geologic Atlas Program Acceleration
Subd. 5j $400,000

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Overall Project Outcome and Results
The County Geologic Atlas program creates geologic maps and associated databases at scales appropriate for resource management, especially ground water management, at the local scale. This grant funded progress on such mapping for Benton and Chisago counties. The counties qualified for participation by establishing accurate digital locations for water wells with construction records that are used as a basic data element in creating the maps. For each county the following products have been constructed:

- Database of well record information with geologic interpretations and a location map;
- Map of the glacial materials occurring at the land surface;
- Map of the bedrock types occurring at the surface of the bedrock;
- Closely-spaced cross-sectional views of the distribution of glacial materials between the land surface and the bedrock surface;
- Map of the elevation of the bedrock surface;
- Map of the thickness of glacial materials above the bedrock surface.

Tasks remaining include:

- Map or maps of the distribution of aquifers within the glacial materials;
- Digital surfaces for multiple sedimentary bedrock formations;
- CD or DVD with digital files of all the maps and databases and a GIS project to display and manipulate those maps and data;
- Printed copies of all the maps. These unfinished products will be created under our 2008 LCCMR grant.

The final outcome of completed county geologic atlases is an understanding of the distribution of aquifers and wells including how the aquifers are connected with each other, how they are connected to the land surface, and how they are connected to surface water features. Hydrologic maps and databases will be created by DNR Waters. The LCCMR funds were augmented with a matching grant of $41,110 from the United States Geological Survey under the STATEMAP program.

Project Results Use and Dissemination
When the additional products for Benton and Chisago counties are complete (expected December 2009 using M.L. 2008 appropriation from the Environment and Natural Resources Trust Fund) a workshop will be arranged to present this work to local users, and to explain how it was created and how it might be applied to resource management. The MGS provides ongoing support of these products as well. Logical applications that have arisen already include the search for municipal well sites for the City of Foley, evaluation of the effects of quarrying on local ground water in Benton County, and an evaluation of the ground water implications of a proposed power plant in Chisago County. Draft versions of some products have already been distributed to parties involved in these issues. The digital versions of the products will be available on CD or DVD and from the website of the Minnesota Geological Survey, and 1,000 printed copies will be distributed to each county. The County Geologic Atlases are a well-known and well-used source of data and geologic interpretations for state and local agencies, consultants, well construction contractors, and citizens. Many of the elements of the atlases are specifically named in the data needs identified in sustainable ground water management plans under development in Minnesota. They are provided in formats appropriate for the complete spectrum of users, including those who don't use

computers through users that require digital files appropriate for modeling and simulation of the ground water system.

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Minnesota's Water Resources: Impacts of Climate Change- Phase II
Subd. 5k $300,000

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RESEARCH

Overall Project Outcome and Results
Minnesota's climate has become increasingly warmer, wetter, and variable, resulting in unquantified economic and ecological impacts. Our team assessed future climate scenarios, quantified hydrologic responses to past climate, conducted an economic analysis to assess implications of changing climate to water resources, and identified water quality and fish indicators of response that could be used for future monitoring. Specific products included:

- Data tools to extract and summarize historic climate data from the State Climatology Office database,
- A water quality reporting tool,
- Climate predictions to the end of the century,
- Assessment of economic impacts of climat change on fisheries and water resources,
- Recommendations of indicators for inclusion in future monitoring programs.

Our findings include the following:

- Temperature increases are projected to be greatest in the latter half of this century, with temperatures generally above 2°C above the average from 1950-1999.
- Precipitation is projected to increase on an annual basis, but will decrease or be unchanged during the growing season, resulting in drier growing conditions.
- Overall, water temperatures in streams are projected to increase between 3 and 5°C.
- Ice out dates were found to be occuring about 1.44 days earlier per decade since the 1950's, and trends for increasing air temperatures in the future imply further declines in ice-free days.
- Historic data were utilized to identify climate periods in the record that were extreme (either due to temperature or precipitation). These extreme periods were then used to assess possible water quality and fish responses during those periods. Indicators of water quality responses were identified (e.g., water clarity, surface water temperature, conductivity); no specific fish responses were detected.
- Walleye spawning dates are changing with ice out dates, and there is evidence that some fish species are expanding their distributions (especially largemouth bass, bluegill and black bullhead). Cisco (tullibee) abundance is declining in northern lakes.
- Water quality and biological indicators were recommended for future monitoring.

Individual project components show detailed analyses and results.

Project Results Use and Dissemination
Project team members and their collaborators have made numerous presentations to general audiences, to agencies, and at professional conferences. Additional outreach and communications products include:

- Data from Kristal Schneider's Master's thesis regarding the relationship between walleye spawning and ice out has been published in the Transactions of the American Fisheries Society 139(4):1198-1210.. http://afsjournals.org/doi/abs/10.1577/T09-129.1. Further publications are planned.
- A mapping tools was created to display trends for lakes having between 5 to >18 years of data. Because of the large number of options for analyzing this broad data set, a comprehensive subproject website was constructed to make the trend results available to other project scientists and ultimately others: (http://mnbeaches.org/gmap/trendswebsite). The website includes "processed raw" data, complete metadata, summary tables, links to Google Maps that identify sites with descriptive statistics, and graphs (box and whisker and regressions). The data are also incorporated into the larger

project database that is now being used for more detailed examinations of climatic associations, geographic patterns, size and depth patterns, and associations with fish, and ice cover data.
- The climate data retrieval tool, developed by the State Climatology Office, was essential to all climatic research undertaken in this project. The climate data retrieval tool enabled project participants to extract climate variables important to their own specific questions, at time and space scales they deem relevant. While the climate data retrieval tool is available to project investigators only at the present time, the Office of the State Climatologist plans to make it available widely to Minnesota resource managers and researchers at the conclusion of this project.
- A third product is an annotated bibliography for the economics of climate change and environmental quality.

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Associated Project Publications

Appendix A: Potential Impacts of Climate Change on Minnesota's Water Resources: An Economic Analysis
Appendix B: Economic Impacts of Global Climate Change on Minnesota Fisheries Through Decreases in Lake Ice
Appendix C: Annotated Literature Review of Economic Analysis of Water Impacts from Climate Change
Appendix D: Online Climatic Data Retrieval Tool
Appendix E: Minnesota Climate in Century 21
Appendix F: Ice-out timing trend analysis for Minnesota lakes 1948-2008
Appendix G: Annual Stream Runoff and Climate in Minnesota's River Basins
Appendix H: Projecting the Impact of Climate Change on Coldwater Stream Temperatures in Minnesota Using Equilibrium Temperature Models
Appendix I: Biological Indicators of Climate Change: Trends in Fish Communities and the Timing of Walleye Spawning Runs in Minnesota
Appendix J: Trend Analyses for Species of Concern: Analysis of CPUE Data for Walleye, Cisco, and Smallmouth Bass 1970-2008
Appendix K: Water Quality Responses During Historical Climate Regimes (Scenarios)

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Pharmaceutical and Microbiological Pollution
Subd. 5l $302,000

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RESEARCH

Overall Project Outcome and Results

The goal of this project was to develop technologies that eliminate antibiotic-resistant bacteria, hormones, and other pharmaceutical compounds from Minnesota's surface waters. Laboratory-scale digesters were established in which wastewater solids were treated under both aerobic and anaerobic conditions at temperatures of 72°F, 98°F, 115°F, and 130°F. Our results demonstrated that aerobic digestion had no significant effect on the destruction of these genes; in contrast, the anaerobic digesters operated at 115°F and 130°F showed a very significant ability to reduce the quantities of these genes (with 130°F performing better than 115°F). This research demonstrates that anaerobic digesters treating wastewater solids (or agricultural manure) should be operated at the highest feasible temperature to help eliminate antibiotic resistance genes, which should help slow the proliferation of these organisms. In terms of antibiotic removal, the aerobic and anaerobic digesters were effective in the removal sulfamethoxazole, trimethoprim, and tylosin, with removal generally being greater at higher temperatures. Digestion did not lead to removal of the antibacterial triclosan or the estrogens tested. Laboratory and pilot-scale photolysis experiments revealed the compounds subject to direct photolysis (triclosan, tetracycline, tylosin) are likely to be amenable to degradation in wastewater treatment stabilization ponds or treatment wetlands. Cover materials either had minimal or inhibitory effects on photolysis rates. Two compounds (sulfamethoxazole and trimethoprim) were photodegraded more rapidly in wastewater effluent than in surface water or purified water, indicating that photodegradation is more likely to occur (and perhaps should be encouraged by design) in sunlit wastewater treatment process steps than in the environment. While solar photolysis shows some promise for treatment of pharmaceuticals, no evidence for removal of antibiotic resistance genes was in the photoreactor.

Project Results Use and Dissemination

This project has been used in numerous ways. First, we have communicated the results back to the State Legislature via informal (i.e., with individual State Senators and Representatives) and formal (i.e., hearings). Second, we have communicated these results to our various partners who operate municipal wastewater treatment facilities as well as other municipalities who operate municipal wastewater treatment facilities. Finally, we have disseminated our research results as broadly as possible, including via presentations at national and regional technical meetings as well as via publication in the peer-reviewed technical literature.

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Project due to be completed: 6/30/2010

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Threat of Emerging Contaminants to Upper Mississippi Walleye
Subd. 5m $97,000

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RESEARCH

Overall Project Outcome and Results
In this combined field and laboratory study we assessed whether populations of native walleye in the Upper Mississippi River experienced altered genetic diversity correlated with the exposure to estrogenic endocrine active compounds. We collected fin-clips for genetic analysis from almost 600 walleye (13 sites) and sub-sampled over 360 of these fish (6 sites) for blood and reproductive organs. We further enhanced our sample size by adding genetic data from over 900 walleye analyzed for previous studies. Finally, we caged male fathead minnows at three of the sample sites to confirm the presence of estrogenic endocrine active compounds. Our findings indicate that male walleye in four river segments produce measurable concentrations of plasma vitellogenin (an egg-yolk protein and, when expressed in male fish, a biomarker of acute estrogenic exposure), a finding consistent with the presence of estrogenic endocrine active compounds and consistent with published historical data for at least three of these study sites (Grand Rapids, Pool 2, Lake Pepin). Patterns of vitellogenin induction were consistent for native walleye and caged fathead minnows. No widespread occurrence of histopathological changes such as intersex was found. To assess the genetic diversity of the walleye populations at the study sites, we DNA fingerprinted individual fish using molecular genetic markers. Genetic differences were observed between populations, however, these differences were consistent with geographic distance between populations (greater geographic distance=greater genetic difference) with the largest observed difference in genetic diversity found between fish upstream and downstream of St. Anthony Falls (and/or Lock and Dam 1 of the Mississippi River), a historical barrier to fish movement. In summary, while the persistent occurrence of endocrine disruption in wild fish populations is troubling, this occurence has not resulted in the degradation of reproductive organs in individual walleye or alteration in genetic diversity of walleye populations.

Project Results Use and Dissemination
Project results have been provided to the LCCMR on a semi-annual basis and in this final report. A related report on some of the genetic findings is also being prepared for the MN Department of Natural Resources. We plan to present the results of this study to the scientific community in form of a peer-reviewed manuscript in the near future. Furthermore, we will present our results to the regional scientific community and stakeholders at upcoming fisheries (i.e., Annual Meeting of the American Fisheries Society, Minnesota Chapter) and toxicological (i.e., Annual Meeting of the Society for Environmental Toxicology & Chemistry, Midwest Chapter) meetings. We have also provided limited project information on the website of the Aquatic Toxicology Laboratory at St. Cloud State University (http://web.stcloudstate.edu/aquatictox/) and will provide a more extensive review of the study after approval of the final report by the LCCMR.

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Cedar Creek Groundwater Project using Prairie Biofuel Buffers
Subd. 5n $659,000

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RESEARCH

Overall Project Outcome and Results
Two great environmental challenges ahead-for Minnesota and the world-concern water and energy. This project has gathered new information on how the production of bioenergy can simultaneously improve water quality in the state. It is one of an integrated suite of existing and proposed projects to understand the potential for bioenergy to help improve wildlife habitat, water quality, natural landscape management, electrical generation efficiency, climate, and the general ecological integrity of the landscape.

The project has established an "underground observatory" to monitor water and what it carries from the surface to our groundwater and aquifers below. The project examined water filtered by the soil and roots beneath three different potential bioenergy sources: prairie, hay, and corn.

As expected, the deep roots of restored native prairies were best at filtering nitrogen contaminants from water. In addition, a number of less expected discoveries of the project will help in future planning and development:

1. Water retention in the soils was poorest in corn and bare ground, intermediate in hay, and greatest in prairie.
2. Prairies did not significantly decrease the total quantity of water re-supplied to groundwater but improved its quality.
3. Nitrogen removed by prairie plants significantly increased the quantity of biofuel they produced while not reducing biodiversity.
4. Effects on levels of pharmaceutical contaminants is still under analysis.
5. Significant carbon sequestration occurred in prairie soils but not those of hay, corn, or bare ground.
6. The downward flow of dissolved substances through even sandy soils is much slower than expected.

The underground observatory is a valuable ongoing resource, with much remaining to learn. The project organizers will seek continued funding from various sources to enable further understanding of how we can sustainably inhabit our planet.

Project Results Use and Dissemination
We have a project website available through the Cedar Creek Natural History Area website (http://www.cedarcreek.umn.edu). Many public and private tours are conducted at Cedar Creek annually and the plots in the present study were featured among them during relevant tours. Visitors receive verbal and written descriptions of the research and its implications, including handouts and review of installed signage. Presentations (oral or poster) to special interest groups, research groups, and other interested parties were given by project collaborators throughout the duration of the project. Publication of the results in a peer-reviewed scientific journal will be completed after field data has all been collected, summarized, and analyzed.

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Project completed: 6/30/2010

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Pyrolysis Pilot Project
Subd. 5o $500,000

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Overall Project Outcome and Results
Diversified perennial plants throughout watersheds in rural areas of Minnesota are a source of biomass feedstock which can

be converted biofuels while also producing ecosystem and water quality benefits. The nature of sporadic production of this biomass in lands away from power and convenient water supply requires conversion technologies to be mobile, portable, self energy sufficient, and water free. The goal of our project was to develop, build, and demonstrate a mobile microwave assisted pyrolysis system which can be operated on biomass production sites. The two specific aims of the project were: (1) developing water free microwave assisted pyrolysis (MAP) system for conversion of cellulosic feedstocks to biofuels, and (2) demonstrating the technology through outreach and communication. We first optimized the processes which we developed from our previous research. Based on the optimized processes, we designed and constructed our first generation pilot system. We then conducted a series of pilot scale experiments and identified technical and engineering problems. Finally we designed and built the mobile demo system. Our pilot scale system has been demonstrated to more than 300 people including university researchers, government officials, private interests, biomass feedstock producers, bioenergy producers, students, and investors. The mobile system has been tested on the manufacture site and further testing will occur in Minnesota at the University of Minnesota's UMore Park. The technology developed was presented to a broader audience through more than 15 outreach events. Nine (9) peer-reviewed papers have been published and over 30 presentations and reports were made to the public. Our co-PI's company Rural Advantages also developed and offered numerous educational outreach and demonstration events totaling over 78 events with 285 speakers and reaching at least 5,410 attendees.

Project Results Use and Dissemination
Information obtained from the project was disseminated through demonstration of the static pilot scale system, outreach and educational events, and peer-reviewed publications. The results have successfully reached a wide range of audience including university researchers, government officials, private interests, biomass feedstock producers, bioenergy producers, students, and investors. A number of publications have aroused strong interests from investors. The project also led to efforts to seek additional funding to support work which will employ the new technology and system developed through this project.

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Project completed: 6/30/2010

Subd. 6 Natural Resource Information

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Minnesota County Biological Survey
Subd. 6a $1,500,000

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Overall Project Outcome and Results
This appropriation continued and accelerated the ongoing Minnesota County Biological Survey (MCBS), which identifies significant natural areas and systematically collects and interprets data on the distribution and ecology of native plant communities, rare plants, and rare animals. The information gathered by MCBS serves as a foundation for the conservation of critical components of Minnesota's biological diversity through ecological monitoring, environmental review, planning, and critical habitat protection.

In this phase of the MCBS, surveys were completed in Hubbard, Wadena, Itasca, Lincoln, Murray, Cottonwood, Jackson, Watonwan, and Martin counties. Surveys were accelerated in the Border Lakes and Nashwauk ecological subsections. Since 1987, MCBS has added 17,054 new rare feature records to DNR's Rare Features Database. Over 47,000 polygons of native plant communities and over 7,000 MCBS site polygons are available to external customers on DNR's "Data Deli", including MCBS sites of biodiversity significance. Aquatic plant data have been collected from 1,528 lakes.

New locations of animal species documented during this period included Prairie Vole, Chestnut-collared Longspur, Black-throated Blue Warbler, and Four-toed Salamander. Plants documented included *Najas guadalupensis var. olivacea*, a Great Lakes endemic aquatic plant and *Carex supina*, a cliff-dwelling sedge last observed in Minnesota in the 1930's. Sioux quartzite rock outcrop surveys yielded nearly 100 new records of rare plants. Since 1987, Twenty-one species and one hybrid not previously documented in Minnesota were recorded, with a 2008 addition of the aquatic plant *Potamogeton confervoides*.

Project Results Use and Dissemination
Data delivery and technical assistance were provided as related to:

- Forest certification
- DNR and US Forest Service forest planning
- Peatland management planning
- State land exchanges
- Woody and grasslands biomass guidelines
- Off Highway Vehicle guidelines
- State Wildlife Action plan implementation
- Quality lake identification
- Forest legacy projects
- Landscape collaborative planning
- Lake and native prairie monitoring
- Native prairie bank
- Updates to the state lists of rare species and calcareous fens.

Locally, aquatic plant data were delivered to lake associations, staff led field trips for county residents, and training sessions in plant community and plant identification. The publication, Native plant communities and rare species of the Minnesota River Counties was well-received by communities bordering the river corridor.

MCBS provided ecological evaluations for Franconia Bluffs, Seminary Fen, Butternut Valley Prairie, and Langhei Prairie that have since become Scientific and Natural Areas.

A statewide web map of the current extent of native prairie as compared to 100 years ago informs prairie ecosystem conservation planning. Another product is an easily downloaded booklet of the Ecological Systems in the Laurentian Mixed Forest Province.

Several MCBS related articles have been published in the *Minnesota Conservation Volunteer*; examples include "Elusive orchids" and "Rock pools on the prairie".

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Soil Surveys
Subd. 6b $400,000

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Overall Project Outcome and Results
In the ongoing multi-year process to map, classify, interpret and Web-publish an inventory of the soils of Minnesota, this two-year phase of the project focused on accelerating the completion of soil mapping, developing new soil interpretations and developing linkages of soils data with other related natural resources data. Specifically:

- 165,000 acres were addressed in Crow Wing County resulting in a digital soil survey for a portion of Crow Wing County, the Glacial Lake Brainerd area, to be released in the fall of 2009;
- 80,000 acres were addressed by NRCS soil scientists in Koochiching and Saint Louis Counties, resulting in soil mapping for Koochiching County being completed one year ahead of schedule;
- Soil productivity indices for cropland and forests were developed for 84 and 19 counties, respectively, in order to replace the outmoded Crop Equivalent Ratings (CER);
- Web-based decision support system was developed that integrates soils data with other natural resources data;
- Support was provided for the University of Minnesota Land Economics website to better complement USDA Web Soil Survey interpretations;

- Six counties (Cass, Carlton, St. Louis-Duluth subset, Lincoln, Scott and Benton) were digitized and posted on the Web Soil Survey bringing the total to 81 survey areas.

Two key lessons were learned during this 2007 phase that were incorporated into the on-going 2008 and 2009 project. The use of current NRCS employees brought to Minnesota on a work assignment ("detailees") is an efficient way to increase the completion of soil surveys after the initial investigative phase has been completed and a mapping legend has been developed. Additionally, we have determined that the USDA Web Soil Survey system is effective and sufficient for Web-publishing of Minnesota's soil survey data, so an independent system does not need to be developed by the state.

Project Results Use and Dissemination
Digital data through the WEB Soil Survey http://websoilsurvey.nrcs.usda.govare available for 83 project areas (Two additional survey areas have been completed with 2008 funds). Soil interpretations such as soil erosion and forest productivity indices are available at the University of Minnesota Land Economics Website http://www.landeconomics.umn.edu Soils data for areas not yet mapped and digitized are available to the public on a request basis.

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Field Guide for Evaluating Vegetation of Restored Wetlands
Subd. 6c $53,000

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Overall Project Outcome and Results
Wetland mitigations in Minnesota are expected to be required to meet minimum native vegetation requirements for approval in the near future. The *Minnesota Field Guide to Wetland & Buffer Plant Seedlings* was developed as an easy-to-use guide to assist in evaluation of the quality of vegetation in wetland restorations in Minnesota.

Bonestroo staff gathered necessary graphic resources for the guide and met with BWSR and MPCA staff to discuss and refine the project layout and contents. Bonestroo graphic designers developed a layout template for the guide. Plant drawings and art were purchased from artist Mark Muller, and additional photos/graphics for native plant seeds and seedlings gathered by Bonestroo staff. Michael Bourdaghs of MPCA assisted with preparation of an abbreviated description of the Floristic Quality Assessment Index (FQAI) process for inclusion as the field methodology for evaluating wetlands.

A total of 2,450 guides were printed (original proposed 2,000) by Modern Press of St. Paul following a competitive bid process. These were distributed to a variety of state and county agencies, as well as federal agencies with Minnesota offices, professional organizations, and educational groups/institutions. A small number of printed guides and the final print-ready version of the guide were provided to Dan Shaw of BWSR. This project created the first guide of its kind for identifying wetland plants, their seeds and seedlings, as well as information on the wetland vegetation evaluation methodology being developed by MPCA. Printed guides were distributed to wetland professionals through a broad network of groups, professional organizations, and local, state and federal agencies. The *Minnesota Field Guide to Wetland & Buffer Plant Seedlings* is also available as a free of charge downloadable PDF on Bonestroo's website at http://www.bonestroo.com. It is also available to State agencies for posting to their websites, should they choose to do so in the future.

Project Results Use and Dissemination
The *Minnesota Field Guide to Wetland & Buffer Plant Seedlings* is being used as both a printed and online resource by wetland professionals. The guide has been distributed at wetland delineators training sessions, as well as by other wetland and natural resource professional groups. The guide is intended to be a supporting reference for plant identification for the wetland evaluation methodology (FQAI) being developed by the Minnesota Pollution Control Agency. This MPCA-developed methodology is anticipated for completion in 2010. The Guide to Minnesota Wetland and Buffer Plant Seedlings is being promoted both through word of mouth, as well as announcements at meetings, workshops, and conferences, by Bonestroo, agency, and nonprofit staff. A distribution list for printed guides was provided to LCCMR staff along with the final project report in July/August 2009.

Project Publication: Minnesota Field Guide to Wetland & Buffer Plant Seedlings

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Project completed: 6/30/2009

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Appropriation titled "Natural Resources Data Collection and Mapping" BECAME:

DataWorkshop: Democratizing access to Minnesota's data assets - a user friendly data integration and visualization tool
Subd. 6d $49,000

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Overall Project Outcome and Results
Originally developed to facilitate the work behind the Statewide Conservation and Preservation Plan, the DataWorkshop is a tool that allows users to combine and cross reference existing GIS datasets to synthesize new information. The DataWorkshop is now available for use by other users such as the public, municipalities, non-profits, and state and county agencies The ability to integrate existing datasets through a web browser without the need for additional software and with only a basic computer background makes the tool unique. Users previously lacking any such capability are enfranchised and users with GIS resources may find DataWorkshop simpler and more efficient for some analysis tasks.

For example, a user may wish to produce a map of all the lakes larger than 100 acres in the western prairie habitat zone. The user would use this system to select the DNR's lake and habitat zone datasets, select from the lake dataset those lakes with an area greater than 100 acres, and from that subset, only those lakes which overlap the prairie habitat zone.

The project has used free (open source) software technologies to minimize the cost associated with hosting this service on the web. These include UMN-Mapserver, Postgis, and Python. NRRI will temporarily host a demonstration site to allow interested parties to evaluate the system and until a permanent location is determined on a Minnesota state agency website. The project will also be promoted at the upcoming MN GIS/LIS Consortium conference. Although projects of this kind can only be truly evaluated by their long term adoption and use, we are hopeful that this work has been a valuable step towards democratizing access to Minnesota's data assets.

Project Results Use and Dissemination
At the time of writing we are in the final stages of releasing the project, which we will promote through our contacts with agencies, potential users, and the MN GIS/LIS Consortium conference in Duluth in October.

NRRI will host a demonstration version of the website at http://gisdata.nrri.umn.edu/Tracker/DataWorkshop/ - this site should be available starting Jan. 1 2010 when a necessary server upgrade is complete.

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Project completed: 6/30/2009

Subd. 7 Establishment of an Emerging Issues Account

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Emerging Issues Account
Subd. 7 $160,000

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Emerging Issues Account

WENT TO:

Statewide Conservation and Preservation Plan (SCPP) - $147,000

http://www.mnconservationplan.net

The Trust Fund funded Statewide Conservation and Preservation Plan (SCPP) is a collaborative effort providing a long term vision and guide for Minnesota's environment and natural resources. This funding continues and expands this effort by enabling the SCPP team to do additional more in-depth analysis on transportation and mercury issues in Minnesota.

Project completed: 6/30/2009

and

Statewide Ecological Ranking Conservation Reserve Program (CRP) and Other Critical Lands - $13,000 (completion date for this portion is 6/30/2009)

Other funds include:
M.L. 2008, Chp. 367, Sec. 2, Subd. 7 "Emerging Issues Account" - $155,000 (completion date for this portion is 6/30/2010)

M.L. 2009, Chp. 143, Sec. 2, Subd. 4g "Statewide Ecological Ranking of Conservation Reserve Program (CRP) and Other Critical Lands" - $107,000 (Project due to be completed: 6/30/2011)

Project due to be completed: 6/30/2011

Project due to be completed: 6/30/2011