

2006 PROJECTS

MN Laws 2006, Chapter 243, Section 19 & Section 20 (beginning July 1, 2006)

Fish and Wildlife Habitat

Land Exchange Revolving Fund for Aitkin, Cass, and Crow Wing Counties

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Section 20, Subd. 08 \$290,000

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To establish a six-year revolving loan fund for Aitkin, Cass, and Crow Wing Counties to improve public and private land ownership patterns, increase management efficiency, and protect critical habitat.

Project due to be completed: 6/30/2011

Water Resources

Lake Superior Research

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Section 20, Subd. 06 \$295,000 (\$267,000 TF + \$28,000 GLP)

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RESEARCH

Overall Project Outcome and Results

There is a surprising lack of study and understanding of the ecosystems of the Great Lakes and their properties, especially in the deepwater basins. We know more about many marine systems than we know about the Great Lakes. With current concerns about the environmental health of the Great Lakes, studies supported through this project aimed to contribute to alleviating some of the unknowns. A series of studies were conducted that research the condition, functioning, and processes of Lake Superior, its sediments, and its ecosystem including:

- Studies related to the entire living ecosystem, from top predator fish down to picoplankton.
- Studies of the circulation of the lake using numerical models and oceanographic instrumentation.
- Studies of the water column including the balance between CO₂ production and oxygen consumption, the processes related to the fate of organic matter and nutrients, and the effect of these and other water column processes on primary producers.
- Studies of the transport and delivery of organic and inorganic materials to the lake floor as sediments that accumulate in deep waters of the lake and the erosion, transport, and storage of coarse-grained sediment in coastal waters.

In all of these studies, we took a holistic, "physics to fish" approach, examining the interactions between physical and biological processes.

We conducted a total of 24 field projects, with project funds going primarily to the cost of using of our research ship for an aggregate of 53 days at sea. Project funds leveraged other funding as most of these studies were small pilot projects, extensions to projects funded from other sources, and projects to collect preliminary data often required for proposals to the national science agencies. The projects have a common theme of understanding the dynamics of Lake Superior, its

sediments, and its ecosystem. Through these studies, we hope to provide Minnesotans, from lay citizens to environmental managers, a better understanding of how Lake Superior works and how it might change in response to climate change and human activity.

Project Results Use and Dissemination

We have now collected a wealth of environmental data for Lake Superior. A significant part of those data have already been used for larger research proposals to the National Science Foundation and other agencies, some of which have already been successful in bringing new federal funding into the state. Plans are for the results of studies supported through this project to be published in peer-reviewed journals where they will be available to Minnesota managers and regulators. With other funding, we are in the process of developing a system called the Global Great Lakes Data and Modeling Center, which will allow incorporation and assimilation of existing data, new data like those collected in this project, and ongoing real-time observational data. The Data and Modeling Center will allow numerical models to be run and compared in real time using the different data sets and make all data readily available through an internet interface.

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Project completed: 6/30/2009

Impacts on Minnesota's Aquatic Resources from Climate Change

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Section 20, Subd. 07 \$250,000

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RESEARCH

Overall Project Outcome and Results

This project examined historic climate records and developed a database on key climatic measures and their variability. We also analyzed hydrologic (e.g., streamflow, lake levels, water quantity and quality) and ecological response data (e.g., fish species distributions, walleye spawning phenology). We found that the following trends are evident:

- Temperatures are increasing throughout the state but changes are greater in the northern third. Changes have accelerated since the 1980s, with greater increases in night time temperatures and in the winter.
- Precipitation in the form of both rain and snow has been increasing since the 1930s, although there is variation across the state.
- Lake evaporation is increasing in some regions but not others. Trends in lake levels are not consistent across the state: some regions show large and significant increases in lake levels, while other regions show no significant trend.
- Stream flows are generally increasing, especially in the south to central part of the state.
- Review of historic ice out data show a trend towards earlier ice out dates across the state. Walleye spawning dates are correlated with ice out date. There is some evidence that fish communities are also changing.
- A sizeable fraction of lakes with many years of data indicated a warming of surface waters. Other trends, found in a smaller fraction of lakes, suggest that the summer thermocline of lakes is becoming somewhat more stable consistent with the warming trend.
- A substantial fraction of lakes in the data set also showed increases in various measures of salinity that are consistent with increased warming and increased watershed loading from stormwater and de-icing salts.
- An interesting trend, likely unrelated to climate, is an increase in water clarity of lakes, and a decline in associated nutrients and chlorophyll-a.

Several tools for downloading and visualizing results have been developed. Additional analyses are ongoing.

Project Results Use and Dissemination

Results of these analyses have been presented in various venues, including:

1. Johnson, L.B. Climate change and Minnesota's aquatic ecosystems. Science Museum of Minnesota, Thursday Evening Lecture Series. Exploring Water. 9 April 2009.
2. Johnson, L.B. Climate change and Minnesota's Aquatic Resources. Symposium. Minnesota Waters, Rochester, MN. May 2009.
3. Johnson, L.B. Adapting to climate change in Minnesota. Invited presentation to Minnesota Pollution Control Agency- Committee to evaluate adaption to climate change in Minnesota. 1 September 2009.

4. Schneider, K.N., D.L. Pereira, V. Card, R.M. Newman, and S. Weisberg. Timing of walleye spawning runs as an indicator of climate change. 138th Annual Meeting of the American Fisheries Society, Ottawa, ON, Canada. 20 August 2008.
5. Schneider, K.N. Timing of walleye spawning runs as an indicator of climate change. Conservation Biology Seminar Series, University of Minnesota, Saint Paul, MN. 16 September 2008.

Project results have been eagerly awaited by numerous agencies and committees working on statewide strategies for assessing adaptation to climate change. Dr. David Thornton invited Lucinda Johnson to present this project's findings to a newly convened committee to address adaptation strategies across state agencies. Results will also be used to inform a newly funded project to quantify impacts of climate change and land use change on cisco habitat (i.e., coldwater lake) in the glacial lakes region of the Midwestern US. In addition, several scientific publications are planned based on results of these analyses.

FINAL REPORT

ASSOCIATED PROJECT PUBLICATIONS:

Appendix A: Timing of Walleye Spawning as an Indicator of Climate Change

Appendix B: Minnesota lake water quality on-line database and visualization tools for exploratory trend analyses

Appendix C: Lake Level Response to Climate in Minnesota

Appendix D: Lake Evaporation Response to Climate in Minnesota

Appendix E: Stream Flow Response to Climate in Minnesota

Appendix F: Minnesota lake water quality on-line database and visualization tools for exploratory trend analyses

Appendix G: Symposium

Project completed: 6/30/2009

Environmental Education

Enhancing Civic Understanding of Groundwater

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Section 20, Subd. 02 \$150,000

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Overall Project Outcome and Results

Ground water is a resource in great and growing demand in Minnesota. Yet many citizens are unaware of the links between land use and ground water and the interconnections between ground water and surface water. The Science Museum of Minnesota, with the help of many partners, created outdoor ground water exhibits for visitors to the Museum and a ground water classroom program for delivery to schools throughout Minnesota.

The creation of the Ground Water Plaza in the Science Museum of Minnesota's outdoor science park, the Big Back Yard, significantly leveraged resources provided by LCMR. The Minnesota Ground Water Association provided \$20,463 to drill the artesian well that provides the water for the ground water exhibits. A gift of \$10,000 from the Toro Giving Program and in-kind donations from numerous entities also helped make the Ground Water Plaza possible.

Since its opening in August 2007, the Ground Water Plaza has become one of the key educational attractions in the Big Back Yard. About 40,000 people visit the park each summer season. The Big Back Yard and the Ground Water Plaza have become so popular as a destination for field trips that the Museum now sets aside two full weeks each September for exclusive use of the park by schools.

The Ground Water Classroom Program began visiting schools throughout Minnesota in spring 2008. The program reached a total of 50 schools and 7,324 students through spring 2009. Although the LCMR project, Enhancing Civic Understanding of Ground Water has concluded, the ground water classroom program will continue to be offered to schools. It is now included under the Water Residency heading on Science Museum of Minnesota's residency program website - <http://www.smm.org/schools/atyourschool/residencies/>.

Project Results Use and Dissemination

The Science Museum and the American Museum of Natural History in partnership produced an internationally traveling exhibit about water that opened in New York City in November 2007. Two Ground Water Plaza outdoor exhibit components

were modified for indoor use and replicated for inclusion in the 7,000 square-foot water exhibition. The National Ground Water Association provided \$54,000 to cover the cost of building these two ground water components. Two copies of the Water exhibition with its ground water components were produced - one to tour North American venues and the second for overseas venues. To date, 712,000 people have seen the Water exhibition with its ground water components and several million more will as the show continues to tour for several more years.

FINAL REPORT

Project completed: 6/30/2009