

16 - 0734

LCMR Final Work Program Report

2003 LCMR Work Program

Date of Report: August 8, 2006 for work completed through June 30, 2006

Date of Work Program Approval: July 10, 2003

Project Completion Date: June 30, 2006

I. PROJECT TITLE: Accelerating and Enhancing Surface Water Monitoring for Lakes/Streams

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Total Biennial LCMR Project Budget:	LCMR Appropriation:	\$ 740,000.00
	Minus Amount Spent as of 6/30/06:	\$ 739,638.31
	Current Balance:	\$ 361.69

Legal Citation: ML 2003, Art. 1, Chap. 128, Sec. 9, Subd. 07b.

Appropriation Language: 7 (b) Accelerating and Enhancing Surface Water Monitoring for Lakes and Streams \$370,000 the first year and \$370,000 the second year are from the trust fund to the commissioner of the pollution control agency for acceleration of agency programs and cooperative agreements with the Minnesota Lakes Association, Rivers Council of Minnesota, the Minnesota Initiative Foundation, and the University of Minnesota to accelerate monitoring efforts through assessments, citizen training and implementation grants. This appropriation is available until June 30, 2006, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

II. and III. FINAL PROJECT SUMMARY:

This project was designed to enhance and accelerate surface water monitoring using a variety of methods. The condition assessment of 172 stream reaches was completed over two monitoring seasons. Monitoring was conducted in the Lower Mississippi, Cedar, Des Moines, Missouri, Red, and Rainy River Basins. This acceleration will lead

¹ Due to a change in work responsibility Gaylen Reetz will no longer be manager of the LCMR funded project. Dan Helwig, Supervisor of the Biological Monitoring Unit at the Minnesota Pollution Control Agency, will replace him as project manager. 8/19/04. Approved per email from Susan Thornton 9/2/04.

to the earlier completion of the calibration of indices of biotic integrity (IBI) for all the basins in Minnesota. All data is available online. Over 10,000 lakes were analyzed using Landsat imagery for transparency over a 20 year span (at 5 year intervals). This provides a tool to extend the census of water quality data across the state and over time. Data from this project are available to the public online. MODIS imagery was used to monitor 100 large lakes for both chlorophyll and transparency. Hyperspectral and in situ data was collected at 37 sites on four river segments to develop a remote sensing tool for rivers. The Lakes and Rivers Monitoring Congress was attended by 325 participants. Fifty citizens, representing 14 groups, completed Monitoring Plan Training. Thirteen plans were developed and monitoring occurred at 153 sites on 66 streams and 80 sites on 56 lakes. With over 95 applications for the 14 openings, this pilot project showed a need for this type of training. The training materials are now available online for interested parties. Ten skills trainings, covering topics from data management to sample collection were attended by 71 groups and 300 individuals. Two editions of the Minnesota Water Watchers newsletter were developed and distributed to 3800 citizens. Healthy Lakes and Rivers Program trained 62 lake or river associations (423 individuals), with 39 Lake Management Plans developed. Volunteers in additional counties are undergoing training as a result of this successful expansion of the program.

IV. OUTLINE OF PROJECT RESULTS

Result 1: Accelerate calibration of biological index

Description: MPCA will accelerate calibration of a biological index used for water quality assessments. Aquatic organisms are excellent indicators of river and stream health. Because they respond to physical, chemical, and biological stressors, they provide a composite measure of water quality throughout the year. Looking at fish and invertebrates in both impacted and relatively undisturbed stream segments within a region develops the Index of Biological Integrity (IBI). This information is then used to determine the biological condition of rivers and streams during water quality assessments.

The MPCA began IBI's in the early 1990's. IBI's have been completed for the Minnesota (partial), Red (partial), St. Croix, and Upper Mississippi River Basins. IBI's sampling has been completed for the Lake Superior Basin but the results won't be analyzed until February, 2004. Work has not begun in the Lower Mississippi, Rainy, Cedar, or Des Moines River Basins. At current staffing levels, this work will not be completed until after 2010. Proposed funding at \$800,000 would have accelerated the completion of the IBI for the state to 2005. The \$350,000 funding level recommended by LCMR would have accelerated the completion date to 2007. The current funding level at \$260,000 will accelerate the completion to 2008. This work is a prerequisite in order to conduct other biological water quality assessments in an area.

March 04 – May 04: Hire, train, and outfit one field sampling crew consisting of 1.3 FTE biologists, and 3 interns. (This crew will work with 2 existing crews at the MPCA).

May 04-Sept 04: Sample 50 sites in the lower Mississippi river basin for fish, invertebrates, habitat, and water quality chemistry

Oct 04-April 05: Compile and analyze data, prepare interim reports, and select sites for 05 field season

May 05-Sept 05: Sample 50 sites in the Rainy or Red River for fish, invertebrates, habitat, and water quality chemistry

Oct 05-March 06: Compile and analyze data and prepare interim report.

March 06: Report. Report will include a calibrated Index of Biotic Integrity for the lower Mississippi River to be used to assess conditions and a summarization and documentation of results.

Summary Budget Information for Result 1: LCMR Budget	\$ 260,000.00
Amount Spent as of 3/30/06	\$ 260,000.00
Balance	\$ 0.00
Other Funds	\$ 242,000
Balance	\$ 0

Completion Date: March 30, 2006

Plan for completion of current work program and overlap of continuation work program:

Result 1 anticipates completion of funds for the current 2003-2006 LCMR work program by September 30, 2005. At that point analysis of the data will be completed and a final report will be developed and is anticipated to be included in the March 30, 2006 update. Upon the completion of the current work program funds, the new 2005-2008 LCMR work program funds will begin (approximately October 1, 2005). Amended 4/8/05. Approved 4/12/05 per Susan Thornton phone call.

²Final Report Summary June 30, 2006:

Using LCMR funds, the assessment of the condition of 172 Minnesota stream reaches was completed. Fish, invertebrate, water chemistry and habitat were sampled using standard MPCA protocol. Sites were sampled in the Lower Mississippi River Basin (55), Cedar River Basin (14), Des Moines River Basin (16), Missouri River Basin (9), Red River Basin (40), and Rainy River Basin (38). Sampling results and protocols are both available online at www.pca.state.mn.us/data/edaWater/index.cfm and www.pca.state.mn.us/water/biomonitoring/bio-streams.html, respectively. In addition to the acceleration of monitoring efforts, staff also developed:

- The use of PC Tablet field computers, greatly reducing the time needed to enter data and accelerating the speed in which data was available online.
- Developed a GIS program to automate land use ranking for each site, increasing the speed and accuracy of assessments.
- Developed an intern orientation program to help students with sampling and safety procedures.

Result 2: Provide the capability to use remote sensing tools to assess lakes and streams.

² Final report will be developed for all results for the June 30, 2006 end date. This was discussed with Susan Thornton via phone on 2/20/2006.

Description: The University of Minnesota Water Resources Center and Remote Sensing Laboratory will use satellite remote sensing technology to assess the quality of lakes statewide and conduct research to evaluate the potential of remote sensing technology for assessing stream properties.

- **Statewide monitoring of lakes by satellite remote. (\$115,000)** — Over the past 5 years the University has developed the capability to monitor lake water clarity, an indicator of water quality, with Landsat Thematic Mapper data. The capability is based on consistently strong relationships between the spectral-radiometric responses of the Landsat TM bands and Secchi disk transparency. Lake clarity is strongly correlated with algae concentration. Each Landsat image can provide a “snapshot” of information on hundreds of lakes, allowing for cost effective evaluation of many hundreds of previously unmonitored lakes. This project will:
 - ***July 03 – May 06:** Extend the existing temporal series of lake clarity classifications back to 1985 and forward to 2004, providing a 20-year record for analysis. New Landsat imagery for 2003-05 will be acquired during the summer 2005 and classified during the fall and winter of 2005.
 - ***January 04 – June 06:** Conduct trend analysis using previous (1990 and 2000) and new classifications and relate lake clarity to land use/land cover.
 - July 03 – December 05:** Validate statewide clarity results, including investigating the effects of humic color and sediment, to improve upon estimates of average summer clarity, using CLMP, MPCA and MDNR monitoring data.
 - ***July 04 – December 05:** Develop procedures for more frequent monitoring of large lakes (> 10,000 acres) using the new MODIS sensor on NASA’s Terra and Aqua satellites. Although it has only 1000-meter spatial resolution, this system has high temporal resolution, ensuring acquisition of cloud-free imagery. Bay-to-bay differences will be classified for selected large lakes.
 - ***July 03 – June 06:** Maintain MapServer GIS database for archival and dissemination of data via the Internet, including links to MDNR and MPCA databases and websites. Package classification statistics by county in tabular and GIS formats.
 - ***July 04- June 06:** Summarize and document results. Conduct workshops and provide documentation needed to transfer technology to state agencies³.

*Milestones were updated as of 4/8/05 to sync with the project end date of June 30, 2006. Approved per 4/12/05 Susan Thornton phone call.

- **Evaluation of remote sensing technology for monitoring streams. (\$65,000)**
Technology similar to that available for lakes holds potential to provide initial evaluation of river and stream water quality. However, due to their dynamic nature

³ Research findings were presented at the 2005 Annual North American Lake Management Society meeting in Madison, Wisconsin. This venue provides a large audience of water resource professionals in which to share the data provided by this project. Amended 2/22/06. Approved via Susan Thornton email 2/23/06.

and spatial characteristics, rivers present a number of technical challenges not encountered with lakes. Therefore the objective of this part of the project will be to determine the degree to which key Minnesota river water characteristics can be assessed and monitored with remote sensing. Key water quality indicators that may be amenable to multispectral remote sensing include, total suspended solids, turbidity, chlorophyll. This project will:

July 03 – December 03: Review literature describing previous research on remote sensing of stream characteristics, and define approaches for acquisition of remote sensing and in-situ data. It is anticipated that the remote sensing data will be acquired by an aerial multispectral sensor because we will have more control over the timing and acquisition of imagery directly over the rivers. Focus may be on the Minnesota River Basin, due to the availability of data for comparisons.

January 04 – *June 04: Specify sensor system, the river segments, and the river sampling and measurements plan. Contract for collection of acquisition of remote sensing imagery. Arrange for in-situ data collection in cooperation with MPCA and other agencies.

***August 04:** Collect remote sensing imagery and in-situ water quality data for calibration of remote sensing data in spring prior to development of full crop canopy and during July or August during the “green water” phase.

***September 04 – March 06:** Process and analyze remote sensing data and relate to trophic status and water quality conditions in river segments.

***March 06 – June 06:** Summarize and document results, including evaluation of feasibility and recommendations for future data collection.

*Milestones were updated as of 4/8/05 to sync with project end date of June 30, 2006.

Summary Budget Information for Result 2:	\$ 180,000.00
Amount Spent as of 12/30/05	\$ 179,998.28
Balance	\$ 1.72

Completion Date: June 30, 2006

Plan for completion of current work program and overlap of continuation work program:

Result 2 anticipates utilizing funds from the current (2003-2006) work program until approximately April 2006. At that point the new (2005-2008) work program funds will begin. However, new (2005-2008) funds will be needed summer of 2005 for the collection of aerial multispectral data. This data must be collected as part of the new project, but will not undergo analysis until the current (2003-2006) work has been completed. Amended 4/8/05. Approved per Susan Thornton phone call 4/12/05.

Final Report Summary: June 30, 2006

The project has developed and extended the capability for using remote sensing for monitoring the condition of lakes and streams in Minnesota. Classification of lake clarity using Landsat satellite imagery has proven to be an accurate and economical method to monitor the condition of over 10,000 lakes. During the project, data from 1985, 1995, and 2005 were classified and added to previous classifications for 1990 and 2000. The five classifications over a 20-year period provide an unprecedented assessment of lakes in terms of number of lakes, number of classifications, and geographic scale. These data will be used for further analysis of the temporal and geographic patterns and trends. Initial analysis for 1990 and 2000 indicates relatively stable conditions statewide, but more meaningful analyses are now possible for individual lakes, as well as by lakeshed, watershed, county, and ecoregion. Data for all lakes and years are available at our www.water.umn.edu webpage that includes a web-based mapping tool that enables searches and display of results for individual lakes. In addition, we have demonstrated the potential of MODIS imagery for monitoring lake clarity and chlorophyll of large lakes (typically greater than 1000 acres). These capabilities are now available for routine, regular monitoring by the state.

The second part of the project has been to acquire and analyze hyperspectral imagery of a representative sample of major streams, including the Mississippi, Minnesota, St. Croix, Blue Earth, and Crow Rivers, to evaluate the potential for mapping key biophysical properties and indicators of water quality. Strong relationships to key indicators of water quality, including chlorophyll, suspended sediments, and transparency were found; models of spectral reflectance to the biophysical variables were derived and used to map spatial patterns and variation for the streams. This phase of the project is being continued in the 2005 LCMR continuation project with additional imagery acquired in 2005, however, the initial results are very promising and indicate excellent potential for monitoring and mapping key river properties. The biggest limitation is expected to be the cost of the remote sensing data.

The overall conclusion of the project is that lake and stream properties can be accurately monitored and mapped using contemporary remotes sensing technology. The Landsat application for monitoring lake clarity, a key indicator of water quality, is ready for routing, operational use by the state. Further research and development, as well as ready access to an appropriate sensor system, will be required to bring the capability for monitoring streams to fruition. Further detail can be found in Appendix B.

Result 3: Enhance and expand ability of citizen volunteers to collect water quality data that will be useful for lake and stream assessments and management.

Description: The Minnesota Lakes Association (MLA) and the Rivers Council of Minnesota (RCM) will work collaboratively to provide training, technical support, education, and communications for individuals and organizations statewide interested in volunteer lake and stream monitoring. Many Minnesotans are interested in water quality monitoring; however, there is a lack of training on how to plan and carry out data collection, analysis, and management. This result will train volunteers to design and execute a monitoring program on their local water body and will ensure that the volunteer data is useful for its intended purpose.

Communications between the groups involved with training to develop and enhanced volunteer monitoring programs will be facilitated through dedicated information on both the RCM and MLA web sites. A newsletter will be developed and published twice during the project period targeted to reach all volunteer monitors in Minnesota with information on acceptable monitoring procedures, monitoring resources, and reports on the project trainings.

- **Plan and Hold Lakes and Rivers Monitoring Congress (\$48,242)**

MLA and RCM will plan and hold a lake and rivers conference, which will include a series of workshops, training and plenary sessions that form the agenda of a Monitoring Congress held concurrently with the Conference. It will be targeted for 250-300 citizen volunteers, local governments, schools, and local natural resource professionals. The workshops and sessions will be designed to improve understanding of key water resource issues and enhance monitoring skills of citizen volunteers. A participant fee will be charged to cover the cost of lodging and food.

Aug 03 – May 04: Planning and organizing the conference will be done by RCM and MLA staff and volunteers. Between Aug. and May the conference planning work will focus on: a) program planning to develop program and identify speakers for plenary, concurrent sessions, and workshops; b) communications to publicize the event and recruit participants; and overall management of conference budget, facilities and logistics.

April 29-May 1, 04: Hold Lakes and Rivers Conference

- **Develop and Implement 14 New Volunteer Monitoring Program Plans**

July- Oct 03: RCM, MLA with support of a sub-contractor (River Network) will begin developing a Citizen Volunteer Monitoring Program Planning and Implementation training workshop including workbooks, planning materials, session agendas, participant assignments, training techniques and presentations.

Nov 03 – March 04: RCM and MLA will hold the first training session for 7 citizen volunteer monitoring groups. Each group will produce a monitoring plan for their targeted stream or lake through the two-day training session. Each group may send up to 3 leaders to the training. Upon completing their monitoring plan each group will be provided up to \$3000 for plan implementation

Aug - Oct 04: RCM and MLA will evaluate and adjust first round of training and follow-up with participants, and hold the second round of training for 7 additional new groups to volunteer monitoring

Oct 04 – Mar 05: RCM and MLA will evaluate and adjust the second round of this pilot program. There will be continued communication with participants and follow-up between sessions and after the plans have been written.

***March 05 – June 06:** Volunteer groups complete monitoring season and submit reimbursements and final reports.

***June 06:** Final Report Submitted

*Milestones updated 4/8/05 to sync with project end date of June 30, 2006.

Approved 4/12/05 per Susan Thornton phone call.

- **Develop and Implement 20 Volunteer Monitoring Program Expansion or Enhancement Projects**

RCM and MLA will develop and deliver 8 training sessions designed to build specific skills for up to 20 existing Citizen Volunteer Monitoring Groups, who will develop and implement project plans to enhance or expand their current programs

May - Aug 04: RCM and MLA will hold 2 skills building training sessions for a total of up to 5 groups. Upon completion of their training session, each group will be provided up to \$500 to implement monitoring program enhancement or expansion project plans developed during training.

Aug 04 – April 05: RCM and MLA will hold 6 additional sessions for a total of up to 15 additional groups and provide up to \$500 to implement monitoring program enhancement or expansion project plans developed during the training.

***April 05 – September 05:** RCM and MLA, via subcontractors, will provide training, equipment, and/or laboratory analysis for volunteers. This will eliminate the pass through of funds to groups and instead provide training and necessary equipment or services for volunteers to complete monitoring (Amended 4/8/05).

Summary Budget Information for Result 3: LCMR Budget	\$ 250,000.00
Amount Spent as of 3/30/06	\$ 249,640.03
Balance	\$ 359.97

Completion Date: June 30, 2006

Plan for completion of current work program and overlap of continuation work program:

The Rivers Council of Minnesota will expend all their current work program (2003-2006) funds by June 30, 2005 with the exception of \$9,000 which will be utilized during the summer of 2005 by volunteers to complete monitoring. New (2005-2008) funds will begin July 1, 2005. Volunteers will submit final reports by December 2005.

The Minnesota Lakes Association will expend all their current work program (2003-2006) funds by approximately September 30, 2005, with the exception of outstanding monitoring plan training funds which volunteers will be utilizing. New (2005-2008) funds are anticipated to begin October 1, 2005. Volunteers will submit final reports by December 2005, with the exception of one group which will submit a final report by June 30, 2006. Amended 4/8/05. Approved 4/12/05 per Susan Thornton phone call.

Minnesota Waters (formerly known as MLA) will purchase a YSI meter/case, closing out funds on the MLA budget (see Appendix A for details) for continued trainings in the 05-07 LCMR continuation grant. The cost of the equipment is \$2,499.49. The equipment will be used in the upcoming lake sampling trainings, the sampling method portion of the "Design Your Monitoring Plan" training program, and individually with groups looking to

practice with the equipment on their own waters. Amended 6/13/06. Approved via Susan Thornton email 6/13/06.

Final Report Summary: June 30, 2006

Minnesota Waters (formerly Rivers Council of Minnesota and Minnesota Lakes Association) developed trainings for hundreds and distributed educational materials to thousands of Minnesotans during this LCMR appropriation.

In 2004, Minnesota Waters hosted the Lakes and Rivers Conference. Over 325 participants attended the statewide conference which included 35 sessions and workshops. Topics covered varied, including water issues, monitoring, communication, and capacity building.

The Minnesota Water Watchers newsletter was developed and first published in the winter of 2004, with a second edition printed in the spring of 2005. Over 3,800 citizens received each edition, with topics ranging from resources and education to information on how to sample waterbodies. Both are available online at: http://www.riversmn.org/resources_citmon.html.

The pilot Monitoring Plan Trainings were held in the fall of 2003 and the spring of 2004. Fourteen groups (50 individuals) attended the trainings, with thirteen of the groups completing Monitoring Plans for their specific waterbodies of interest. These plans included monitoring at 153 stream sites on 66 different streams and 80 lake sampling locations on 56 lakes. Between trainings, the process was evaluated to improve the training process. Remaining funds were the result of two groups not completely spending the implementation funds received as part of the Monitoring Plan Training. More detail on the specific groups and their outcomes are available in Appendix C and copies of the completed Monitoring Plans are included in the supporting documents.

Minnesota Waters completed 10 skills training sessions over the course of the LCMR project. Through these trainings, over 300 citizens were trained. Topics ranged from lake and macroinvertebrate sampling, to data interpretation and management. Detail on the specific sessions is available in Appendix C.

Result 4: Develop and begin implementation of up to 14 citizen-led lake or river management plans.

Description: The Minnesota Initiative Foundation will lead up to 14 groups through their Healthy Lakes and Rivers Program (HLRP). This will build the capacity of citizen leaders from these lake associations and/or river groups to develop and implement water resource management plans for their respective watersheds. The plans for managing their water resources will include a locally shared vision, measurable goals and a process to report on their progress and outcomes. This will also provide training, technical assistance and financial support to groups as they go through the process of developing and implementing their water management plan.

LCMR funds will be used to provide training, technical assistance (follow up calls, plan review, etc.), training materials, facility rental for training events, and subcontractor costs associated with training and development of the Lake/River Management Plans for groups in Todd, Douglas, and Stearns Counties. If possible, funds will also be used to facilitate plan development in the following counties: Itasca, Aitkin, Hubbard, Beltrami, Isanti, Pine, Kanabec, Cass, and Crow Wing. Groups will be recruited by local resource managers, who will also participate and provide technical assistance in the trainings. Groups who attend the trainings and meet benchmarks will be qualified for implementation funds provided by alternate funding sources. (This shift in funds is requested as other funds became available to cover implementation funds, freeing LCMR funds to cover training costs. 8/30/04. Approved per email from Susan Thornton dated 9/2/04.)

This will expand this effort beyond the Initiative Foundation's boundaries, providing an incentive and model for other regional Initiative Foundations to engage in this type of effort.

Aug 03 - March 04: Two Leadership Trainings; attended by 8 leaders from 6 groups in Todd and Douglas Counties, 48 total leaders. Each training session is 8 hours.

April 04 – July 04: Facilitated Community Visioning sessions by each group to set goals for a lake or river management plan and draft the plan (Todd/Douglas).

July 04 – June 05: Implementation of priority actions in each of the lake or river management plans (Todd/Douglas).

March 05: Two Leadership Trainings; attended by 8 leaders from 8 groups in Stearns County, 64 total leaders. Each training session is 8 hours.

April 05 – July 05: Facilitated Community Visioning sessions by each group to set goals for a lake or river management plan and draft the plan (Stearns).

July 05 – June 06: Implementation of priority actions in each of the lake or river management plans (Stearns).

***June 2006: Submit final report**

*Milestones amended 4/8/05 to sync with project end date of June 30, 2006. Approved 4/12/05 per Susan Thornton phone call.

Summary Budget Information for Result 4:	LCMR Budget	\$ 50,000.00
	Amount Reimbursed as of 9/30/05	\$ 50,000.00
	Balance	\$ 0.00
	Other Funds	\$ 80,000
	Balance	\$ 0

Completion Date: June 30, 2006

Final Report Summary: June 30, 2006

The Initiative Foundation's Healthy Lakes and Rivers Partnership (HLRP) program worked to expand trainings outside of their regional boundaries through this LCMR appropriation, supporting trainings in Todd, Douglas, Crow Wing, Cass, Stearns, Aitkin, Itasca, Beltrami, Hubbard, and Isanti counties. Over 400 citizens, representing 62 lake

or river groups received HLRP training. Of these groups, 39 completed Lake Management Plans and have since initiated action steps to care for their waterbodies. With the success of this training, other counties and regional Initiative Foundation offices have been able to acquire private funding to continue the trainings in other areas of Minnesota. Example Lake Management Plans and copies of all electronically available plans (20) are available on CD (see supporting documents).

V. TOTAL LCMR PROJECT BUDGET:

All Results: Personnel: \$ 482,269.40

All Results: Equipment: \$ 7,500.00

All Results: Development: \$ 0

All Results: Capital Equipment: \$ 3474.91

All Results: Other: \$ 246,755.69

TOTAL LCMR PROJECT BUDGET: \$ 740,000

Explanation of Capital Expenditures Greater Than \$3,500: None

VI. PAST, PRESENT AND FUTURE SPENDING:

A. Past Spending:

Result 1: The MPCA spends approximately \$250,000 and 5.5 FTE each year on stream monitoring and assessment, and \$35,000 and 2 FTE on detailed lake assessments and trend analysis. Note: This does not include the time spent on general support (database management, equipment maintenance, etc.) or specific problem investigation. Result 2: The University of Minnesota has worked over the last 5 years to develop the remote sensing tool for lakes. Results 3 and 4: Three efforts are underway to provide an essential foundation for Result 3 and 4. First, the MPCA has led an effort to develop a monitoring guidance manual that will be available in July 2003. The intent of the manual is to help volunteers identify purposes for monitoring, select appropriate tests/protocols and help them determine how to store and use the data they generate. Ultimately, the manual will ensure that volunteer monitoring data is useable and will provide support to volunteers in their collection efforts. Second, a detailed inventory and needs assessment of existing monitoring programs has been conducted by RCM and MLA with support from the Bush and McKnight Foundations. Third, an in-depth study of how citizen volunteer monitoring is effectively used in Minnesota has recently been completed (spring 2003) and will aid in recommending how citizen volunteer monitoring can be used more effectively.

B. Current Spending:

MPCA's baseline efforts for stream and lake assessments will continue as outlined in "A." This initiative would augment the MPCA's current efforts, allowing those efforts to be accelerated and improved.

C. Required Match (if applicable). None

D. Future Spending:

VII. Project Partners:

A. Partners Receiving LCMR Funds: University of Minnesota; Minnesota Waters (merged organization of the Rivers Council of Minnesota and the Minnesota Lakes Association); Minnesota Initiative Foundation

B. Project Cooperators: Dr. Pat Brezonik and Dr. Marvin Bauer, University of MN; Angie Becker Kudelka and Bruce Johnson, Rivers Council of Minnesota; Paula West, Minnesota Lakes Association; Don Hickman, Minnesota Initiative Foundation.

VIII. DISSEMINATION: Reports for Result 1 are available on the MPCA website: <http://www.pca.state.mn.us/data/eda/index.cfm>. Workshops will be held to transfer information from Result 2 to state agencies and other interested parties. Information has been presented at a number of conferences (see Appendix B). Information for Result 3 is on the Minnesota Waters (RCM and MLA) website (<http://www.minnesotawaters.org/>) and a newsletter was published twice during the project period. In addition, project information was also distributed via electronic newsletters (*Thalweg*, *Lake Bulletin*, and *The Confluence*), hard copy newsletters, at training events and conferences. Result 4 was shared with other regional initiative foundations as a model.

IX. LOCATION: Result 1 included work in the Lower Mississippi, Cedar, Missouri, Des Moines, Rainy and Red River Basins. Result 2 remote sensing for lakes occurred statewide, while the stream work focused on limited number of rivers in Central and Southern Minnesota in an effort to evaluate potential application statewide. Result 3 was available to citizens statewide. Result 4 focused on Todd/Douglas, Beltrami, Aitkin, Itasca, Hubbard, Crow Wing/Cass, Stearns, and Isanti Counties.

X. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than March 30, 2004; September 30, 2004; March 30, 2005; September 30, 2005 and March 30, 2006. A final work program report and associated products will be submitted in August 2006 as the project concludes June 30, 2006.

XI. RESEARCH PROJECTS

**Appendix A
Budget**

Attachment A: Budget Detail for Proposals - Summary and a Budget page for each partner																									
Proposal Title: Accelerating and Enhancing Surface Water Monitoring																									
Project Manager Name: Dan Helwig, MPCA																									
LCMR Requested Dollars: \$ 740,000																									
2003 LCMR Proposal Budget	Result 1 Budget:	Amount Spent (6/30/06)	Balance (6/30/06)	Result 2 Budget:	Amount Spent (6/30/06)	Balance (6/30/06)	Result 3 Budget:	Amount Spent (6/30/06)	Balance (6/30/06)	Result 4 Budget:	Amount Spent (6/30/06)	Balance (6/30/06)	Result 5 Budget:	Amount Spent (6/30/06)	Balance (6/30/06)	Result 6 Budget:	Amount Spent (6/30/06)	Balance (6/30/06)	Result 7 Budget:	Amount Spent (6/30/06)	Balance (6/30/06)				
	Accelerate biological index			Remote Sensing			Volunteer Training			Healthy Lakes & Rivers															
BUDGET ITEM:	Calibration of biological index			Apply Lake Satellite Remote Sensing			Develop Stream Satellite Remote Sensing			Lakes Training (MLA)			Streams Training (RCM)								TOTAL FOR BUDGET ITEM				
PERSONNEL: Staff Expenses, Wages, salaries & benefits - Be specific on who is paid \$, to do what?	\$206,926.10	1.3 FTE unclassified biologists @ \$66,000 for 2 yrs, 3 summer interns @ \$6000 ea for 2 yrs.	\$206,926.10	\$0.00	\$115,294.05	see Result 2 detail	\$115,294.05	\$0.00	\$37,821.43	See Result 2 detail	\$37,819.71	\$1.72	\$14,750.00	See Result 3 detail	\$14,750.00	\$0.00	\$65,524.34	See Result 3 detail	\$65,524.34	\$0.00	\$41,953.48	See Result 4 detail	\$41,953.48	\$0.00	\$482,269.40
Contracts																									
Professional/technical (with whom?)	\$36,593.90	RFP or master contract for Invertebrate I.d.	\$36,593.90	\$0.00						\$46,885.00	Tower View Enterprises for	\$46,885.00	\$0.00	\$22,500.00	Rivers Network for Monitoring	\$22,500.00	\$0.00	\$600.00	Larry Wannebo, training consultant	\$600.00	\$0.00	\$106,578.90			
Other contracts (with whom?) list out personnel, equipment, etc.	\$0.00	RFP or master contract for fish archiving	\$0.00	\$0.00						\$26,069.30	Training for 7 new and 10 existing groups	\$25,914.75	\$154.55	\$22,736.98	Training for up to 7 new and 10 existing	\$22,736.98	\$0.00							\$48,806.28	
Other direct operating costs (for what? - be specific)							\$13,050.00	two flights to collect low-altitude data	\$13,050.00	\$0.00	\$3,856.29	Expenses to put on training workshops	\$3,856.29	\$0.00	\$20,437.32	Volunteer Monitoring Workshop and	\$20,437.32	\$0.00	\$2,560.87	skills building workshops	\$2,560.87	\$0.00	\$39,906.48		
											\$9,740.00	Printing and postage for newsletter	\$9,740.00	\$0.00	\$500.00	web site enhancements	\$500.00	\$0.00					\$10,240.00		
Printing				\$0.00	maps & reports	\$0.00	\$0.00	\$0.00	maps & reports	\$0.00	\$0.00	\$0.00	\$0.00										\$0.00		
Communications, telephone, mail, etc.											\$5,750.00		\$5,750.00	\$0.00	\$3,672.98		\$3,672.98	\$0.00	\$1,905.05		\$1,905.05	\$0.00	\$11,328.03		
Other Supplies (list specific categories)	\$1,429.27		\$1,429.27	\$0.00	\$575.53		\$575.53	\$0.00	\$175.53		\$175.53	\$0.00											\$2,180.33		
Travel expenses in Minnesota	\$15,050.73	Statewide travel for 1 crew of 5 persons for sampling, 2-4wd suburban leases	\$15,050.73	\$0.00	\$377.64		\$377.64	\$0.00	\$128.04		\$128.04	\$0.00	\$1,097.50	statewide, 1 fte	\$1,097.50	\$0.00	\$2,003.38	statewide, 1 fte	\$2,003.38	\$0.00	\$2,980.60	project staff and subcontractor travel	\$2,980.60	\$0.00	\$21,637.89
Out of State Travel					\$814.78		\$814.78	\$0.00															\$814.78		
Tools and equipment (list categories)	\$0.00	Sampling equip. for crew, e.g. fish shockers	\$0.00	\$0.00	\$7,500.00	Landsat ETM+ images	\$7,500.00	\$0.00															\$7,500.00		
Office equipment & computers					\$3,438.00	Computer lab fees	\$3,438.00	\$0.00	\$825.00	Computer lab fees	\$825.00	\$0.00	\$1,000.00	computer	\$1,000.00	\$0.00							\$5,263.00		
Capital Equipment											\$3,474.91		\$3,269.49	\$205.42									\$3,474.91		
COLUMN TOTAL	\$260,000.00		\$260,000.00	\$0.00	\$128,000.00		\$128,000.00	\$0.00	\$52,000.00		\$51,998.28	\$1.72	\$112,625.00		\$112,265.03	\$359.97	\$137,375.00		\$137,375.00	\$0.00	\$50,000.00		\$50,000.00	\$0.00	\$740,000.00

Detailed Budget for Result 1: Accelerate Biological Index (\$260,000 total budget)
Minnesota Pollution Control Agency

2003 LCMR Budget Detail	^{1,2,4} Budget		Amount Spent (3/30/06)	Balance (3/30/06)	
	Accelerate Biological Index				
BUDGET ITEM:	Calibration of Biological Index				TOTAL FOR BUDGET ITEM
PERSONNEL: Staff Expenses, Wages, salaries & benefits – Be specific	\$206,926.10	1.3 unclassified biologists @ \$66,000 for 2 yrs, 3 summer interns @ \$6000 ea for 2 yrs.	\$206,926.10	\$0.00	\$206,926.10
Contracts					
Professional/technical (with whom?)	\$36,593.90	RFP or master contract for invertebrate identification	\$36,593.90	\$0.00	\$36,593.90
Other contracts (with whom?)	\$0.00	RFP or master contract for fish archiving	\$0.00	\$0.00	\$0.00
Travel expenses in Minnesota	\$15,050.73	Statewide travel for 1 crew of 5 persons for sampling	\$15,050.73	\$0.00	\$15,050.73
Travel outside Minnesota (where?)					
³ Other Supplies (misc supplies during field work)	\$1,429.27		\$1,429.27	\$0.00	\$1,429.27
Tools and equipment (list categories)					
Equipment	\$0.00	Sampling equipment for crew, eg. Fish shockers	\$0.00	\$0.00	\$0.00
COLUMN TOTAL	\$260,000.00		\$260,000.00	\$0.00	\$260,000.00

1: Funds not needed for sampling equipment. Purchased through agency funds. Shifted funds (\$5000) to personnel. Amended 4/8/05. Approved via phone call from Susan Thornton 4/12/05

4: Funds shifted to close out accounts and to match actual expenses. \$13,510.90 was shifted from personnel to professional contracts to cover invertebrate identification costs. An additional \$60 was transferred from Other supplies to contracts. Finally, \$10.73 was shifted from other supplies to travel expenses to close out the account. Discussed with Susan Thornton 6/14/06 via phone and amended.

2: Extra funds from travel shifted to: \$1,500 to Other Supplies to cover expenses accrued in the field, \$3,023 to Invertebrate Contract as final bill was higher than originally expected, and the remaining \$437 shifted to personnel to close out the account and keep staff funded for analysis in the office. The \$5,000 for fish archiving contract was shifted to personnel to keep staff on hand for analysis in the office, archiving costs picked up by MPCA funds. Amended 9/30/05.

3: Other Supplies category added 9/30/05. Was inadvertently missed on original budget. This category covers supplies purchased as needed in the field (preservatives, replacement parts, etc.)

Detailed Budget for Result 2: Remote Sensing (\$180,000 total budget)
Contract with U of MN

2003 LCMR Proposal Budget	^{3,4,7} Result 2 Budget:		Amount Spent (6/30/06)	Balance (6/30/06)	^{2,5,8} Budget		Amount Spent (06/30/06)	Balance (06/30/06)	
	<i>Remote Sensing</i>								
BUDGET ITEM:	<i>Apply Lake Satellite Remote Sensing</i>				<i>Develop Stream Satellite Remote Sensing</i>				TOTAL FOR BUDGET ITEM
*PERSONNEL:	\$115,294.05	Assistant scientist annual salary of \$38,000 for 2 yrs at 72% time & 31% benefits; graduate assistant annual salary of \$16,000 for 2 yrs at 10% plus 67.7% benefits; and 2 project directors at 0.66 mo. of summer salary each for 2 yrs plus 31.8% benefits.	\$115,294.05	\$0.00	\$37,821.43	Assistant scientist annual salary of \$38,000 for 2 yrs at 2% time & 31% benefits; graduate assistant annual salary of \$16,000 for half-time RA and 67.7% benefits; and 2 project directors @ 0.22 mo. of summer salary each for 2 yrs plus 31.8% benefits.	\$37,819.74	\$1.72	\$153,115.48
Contracts									
Other direct operating costs (for what? - be specific)									
Printing	\$0.00	Printing of maps and reports	\$0.00	\$0.00	\$0.00	Printing maps and reports	\$0.00	\$0.00	\$0.00
Advertising									
Communications, telephone, mail, etc.									
Office Supplies (list specific categories)									
Other Supplies (list specific categories)	\$575.53	Research supplies, maps, and software	\$575.53	\$0.00	\$175.53	Research supplies, maps, and software	\$175.53	\$0.00	\$751.06
Travel expenses in Minnesota	\$377.64	Collection of water quality data for calibration	\$377.64	\$0.00	\$128.04	Collection of water quality data for calibration	\$128.04	\$0.00	\$505.68
*Travel outside Minnesota (Madison, WI for North American Lake Management Society Conference)	\$814.78		\$814.78	\$0.00					\$814.78
Tools and equipment (list categories)									
Landsat images	\$7,500.00	18 Landsat ETM+ images @ \$605 per image to cover entire state	\$7,500.00	\$0.00					\$7,500.00
Computer lab fees	\$3,438.00	ERSAC computer facility fees	\$3,438.00	\$0.00	\$825.00	ERSAC computer facility fees	\$825.00	\$0.00	\$4,263.00
Aerial/low altitude sensing data					\$13,050.00	Two flights at \$6000 each to collect aerial multispectral data over rivers.	\$13,050.00	\$0.00	\$13,050.00
Office equipment & computers									\$0.00
Other Capital equipment (specific items)									\$0.00
COLUMN TOTAL	\$128,000.00		\$128,000.00	\$0.00	\$52,000.00		\$51,998.28	\$1.72	\$180,000.00

1. In the event that no graduate assistant applies or is hired for the position, funds will be shifted from 'graduate assistant' to 'assistant scientist'. Amended 4/8/05. Approved per Susan Thornton phone call 4/12/05.

3. As discussed via phone call with Susan Thornton 8/18/05, \$600 was transferred from 2a printing to 2a travel to account for increased expenses. \$0.53 was transferred from Result 2a to Result 2b (Research Supplies, Maps, and Software) to eliminate a negative balance in Result 2b.

5. Budget amended to reflect completion of stream data analysis work and the associated costs. Because work was completed early and savings were incurred for imagery, printing, and supplies, the respective categories were adjusted as follows: personnel reduced by \$12,288, printing reduced by \$75, computer lab fees reduced by \$375, and in state travel reduced by \$287. Amended 2/22/06. Approved via Susan Thornton email 2/23/06.

2. Flights from the 2004 aerial multispectral data flyovers exceeded the allotted budget. Funds were moved from "Develop Stream Satellite Remote Sensing" categories of: personnel (\$750), Printing (\$125), and Research supplies (\$175). Amended 4/8/05. Approved per Susan Thornton phone call 4/12/05.

4. Budget amended to reflect ongoing work in the lake remote sensing to complete data analysis. Primarily, personnel funds were added, while reduced costs for imagery, printing, and supplies were realized. The respective categories were adjusted as follows: increase of \$17,288 in personnel, addition of \$815 to out of state travel (see footnote 6), and reductions of \$3,390 (imagery), \$100 printing, \$306 maps and software, \$912 computer lab fees, and \$395 in state travel. Amended 2/22/06. Approved via Susan Thornton email 2/23/06.

6. Out of state travel added to the project budget. Project staff traveled to Madison Wisconsin in November 2005 to present project findings at the NALMS conference proceedings. Amended 2/22/06. Approved via Susan Thornton email 2/23/06.

7. Funds shifted from Printing (\$50), Travel (\$0.22), and Lab fees (\$150) to personnel (\$200.22) to close out all accounts. Preapproved via Susan Thornton email 3/31/06. Amended 7/26/06.

8. Funds shifted from Printing (\$50), Supplies (\$24.47), Travel (\$2.96), and Lab Fees (\$300) to Personnel (\$377.43) to close out all accounts. Preapproved via Susan Thornton email 3/31/06. Amended 7/26/06.

Detailed Budget for Result 3 RCM: Volunteer Training Streams (\$137,375 total budget)
 Contract Rivers Council of Minnesota

2003 LCMR Budget Detail	Budget ^{2,4}	Description	Amount Spent (3/30/06)	Balance (3/30/06)	Budget ^{3,5}	Description	Amount Spent (3/30/06)	Balance (3/30/06)	Budget ⁶	Description	Amount Spent (3/30/06)	Balance (3/30/06)	
Result 3: Volunteer Training Streams Training (RCM)	Monitoring Congress				Monitoring Program Development & Implementation				Volunteer Monitoring Program Enhancement /				
BUDGET ITEM													TOTAL FOR ITEM
PERSONNEL: Staff Expenses, Wages, salaries & benefits ? Be specific on who is paid \$, to do what?	\$16,577.60	RCM: .169 FTE @ \$30,000/yr (\$8,700) plus 19.92% benefits (\$1,733) = \$12,159.89 X 64% for this result; .04 FTE @ \$18,875/yr (\$1510) plus 20% benefits (\$302) = \$1812 X .15 for this result; .54 FTE @ \$36,300/yr (\$36,300) plus 25% benefits (\$8,853.57) = \$49,135.12 X 17% for this result.	\$16,577.60	\$0.00	\$34,221.06	RCM: .04 FTE @ \$18,875/yr (\$1510) plus 20% benefits (\$302) = \$1812 X .85 for this result; .54 FTE @ \$36,300/yr (\$36,300) plus 25% benefits (\$8,853.57) = \$49,135.12 X 60% for this result; .169 FTE @ \$30,000/yr (\$8,700) plus 19.92% benefits (\$1,733) = \$12,159.89 X 27% for this result	\$34,221.06	\$0.00	\$14,725.68	RCM: .169 FTE @ \$30,000/yr (\$8,700) plus 19.92% benefits (\$1,733) = \$12,159.89 X 9% for this result; .54 FTE @ \$36,300/yr (\$36,300) plus 25% benefits (\$8,853.57) = \$49,135.12 X 23% for this result	\$14,725.68	\$0.00	\$65,524.34
Professional/technical (with whom?)					\$17,500.00	Contract with River Network for Monitoring Design Plan program development and implementation for lakes and rivers.	\$17,500.00	\$0.00	\$5,000.00	RCM will hire contractors (to be determined) to assist in designing and conducting up to 4 skills training sessions in subresult 3C.	\$5,000.00	\$0.00	\$22,500.00
Development and Implementation of Monitoring Program and Project Plans					\$18,000.00	Up to \$3,000 per group X 6 river groups to design and implement a volunteer monitoring program.	\$18,000.00	\$0.00	\$4,736.98	7 Benthic Macroinvertebrate Training provided by RCM and a subcontractor (to be determined). Equipment provided for training and for volunteer use by subcontractor.	\$4,736.98	\$0.00	\$22,736.98
Other direct operating costs (for what? ? be specific)	\$17,152.36	Volunteer Monitoring Workshop: Rent facility, develop program, recruit speakers, and, materials	\$17,152.36	\$0.00	\$1,854.15	Expenses to conduct monitoring program plan training sessions including rent facility, develop program, and provide materials	\$1,854.15	\$0.00	\$1,430.81	Expenses to conduct skills training workshops to expand/enhance programs and develop and implement project plans (\$500 workshop X 4 workshops).	\$1,430.81	\$0.00	\$20,437.32
	\$500.00	RCM web site enhancements	\$500.00	\$0.00									\$500.00
Printing													
Direct Costs: Communications, telephone, mail, general office, etc.					\$2,285.35		\$2,285.35	\$0.00	\$1,387.63		\$1,387.63	\$0.00	\$3,672.98
Travel expenses in Minnesota					\$928.31		\$928.31	\$0.00	\$1,075.07		\$1,075.07	\$0.00	\$2,003.38
Travel outside Minnesota (where?)													\$0.00
Office equipment: Computer Station													\$0.00
Other Capital equipment (list specific items)													\$0.00
COLUMN TOTAL	\$34,229.96		\$34,229.96	\$0.00	\$74,788.87		\$74,788.87	\$0.00	\$28,356.17		\$28,356.17	\$0.00	\$137,375.00

1: Personnel fund shifted due to position elimination at Rivers Council of Minnesota 3/30/04. Approved per Susan Thornton email dated 4/6/04.
 2: Funds shifted from meeting expense to personnel for Result 3a. More staff expense accumulating than eligible meeting expenses. 8/19/04 Approved via email from Susan Thornton dated 9/2/04.
 3: Funds shifted from Monitoring Plan development to personnel in Result 3b. One group didn't complete training, funds to cover cost of additional follow-up technical support after workshop training sessions. 8/19/04 Approved via email from Susan Thornton dated 9/2/04
 4: All categories closed out for Result 3a. Remaining funds (\$165.64) shifted to Result 3c personnel. Amended 4/8/05. Approved via phone call 4/12/05 per Susan Thornton
 5: Categories for monitoring plan training expenses, communications, and travel for result 3b closed out. Remaining funds (\$631.42) shifted to Result 3c personnel. Amended 4/8/05. Approved 4/12/05 per Susan Thornton phone call.
 6: Funds shifted from closed out categories in 3a and 3b added to result 3c personnel. Any remaining funds in 3c categories other than personnel as of 6/1/05 will be shifted to 3c personnel. Amended 4/8/05. Approved via phone call 4/12/05 with Susan Thornton.
 7: In lieu of pass through funds to volunteers, benthic macroinvertebrate training will be held and volunteers will receive monitoring equipment to complete monitoring. Approved 4/12/05 per phone call with Susan Thornton
 8: Funds shifted from communications (\$50.77) to personnel to close out budget categories with 6/30/05 reimbursement. Amended 6/23/05. Approved 7/7/05 via email from Susan Thornton.
 9: Funds shifted from communications (\$1112.37), travel (\$174.93), meeting expenses (\$569.19), and develop of monitoring plan (\$263.02) to personnel to close out budget categories with 6/30/05 reimbursement. Amended 6/23/05. Approved via email 7/7/05 from Susan Thornton.

2003 LCMR Proposal Budget	^{1,5} Budget	Budget Detail	Amount Spent (6/30/06)	Balance (6/30/06)	^{1,2,5,6} Budget	Budget Detail	Amount Spent (6/30/06)	Balance (6/30/06)	^{1,4,6} Budget	Budget Detail	Amount Spent (6/30/06)	Balance (6/30/06)	
Result 3: Volunteer Training Lakes Training (MLA)	Monitoring Congress				Monitoring Program Development & Implementation				Volunteer Monitoring Program Enhancement / Expansion				
BUDGET ITEM													TOTAL FOR ITEM
PERSONNEL: Staff Expenses, Wages, salaries & benefits ? Be specific on who is paid \$, to do what?	2,865.38	.1 FTE wages and benefits for administrative assistance for Monitoring Congress at \$23,000/year + 22% benefits.	\$2,865.38	\$0.00	\$5,942.12	\$5942.50 for administrative assistant and support staff	\$5,942.12	\$0.00	\$5,942.50	\$5942.50 for administrative assistant and support staff	\$5,942.50	\$0.00	\$14,750.00
Professional/technical (with whom?)	4,200.00	Consultant with Tower View Enterprises (\$50/hour X 84 hours)	\$4,200.00	\$0.00	\$31,235.00	Consultant with Tower View Enterprises (\$50/hr x 624.7 hr)	\$31,235.00	\$0.00	\$11,450.00	Consultant with Tower View Enterprises (\$50/hour X 229 hours)	\$11,450.00	\$0.00	\$46,885.00
Development and Implementation of Monitoring Program and Project Plans					\$21,000.00	Up to \$3,000 per group X 7 lake groups to design and implement a volunteer monitoring program.	\$20,845.45	\$154.55	\$5,069.30	\$500 per group X 10 lake groups to enhance or expand their existing monitoring program after attending skills training workshops. Remaining funds to be used to	\$5,069.30	\$0.00	\$26,069.30
Other direct operating costs (for what? ? be specific)					\$2,000.00	Expenses to conduct monitoring program plan training sessions including rent facility, develop program, and provide materials	\$2,000.00	\$0.00	\$1,858.29	Expenses to conduct skills training workshops to expand/enhance programs and develop and implement project plans (\$500 workshop X 4 workshops). Remaining funds to be used to	\$1,858.29	\$0.00	\$3,858.29
					\$4,870.00	Printing and postage for two newsletters to volunteer lake and stream monitors throughout Minnesota; MLA web site enhancements .	\$4,870.00	\$0.00	\$4,870.00	Printing and postage for two newsletters to volunteer lake and stream monitors throughout Minnesota; MLA web site enhancements .	\$4,870.00	\$0.00	\$9,740.00
Printing													
Advertising													
Direct Costs: Communications, telephone, mail, general office, etc.					\$2,875.00		\$2,875.00	\$0.00	\$2,875.00		\$2,875.00	\$0.00	\$5,750.00
Travel expenses in Minnesota					\$650.00		\$650.00	\$0.00	\$447.50		\$447.50	\$0.00	\$1,097.50
Travel outside Minnesota (where?)													
Office equipment: Computer Station					\$500.00	PC station	\$500.00	\$0.00	\$500.00	PC station	\$500.00	\$0.00	\$1,000.00
³ Capital Equipment					\$770.00	Monitoring equipment for training and dissemination to volunteers	\$770.00	\$0.00	\$2,704.91	Monitoring equipment for training and dissemination to volunteers	\$2,499.49	\$205.42	\$3,474.91
COLUMN TOTAL	7,065.38		\$7,065.38	\$0.00	\$69,842.12		\$69,687.57	\$154.55	\$35,717.50		\$35,512.08	\$205.42	\$112,625.00

1. Funds shifted from personnel on Monitoring Congress to personnel on Monitoring Program Development and Implementation and Volunteer Monitoring Program Enhancement/Expansion Projects. Underestimated need for staff time on last two components. 8/30/04. Approved per email from Susan Thornton dated 9/2/04.
 2. Funds shifted from 3b personnel and travel expenses (over estimates in both categories) to contracts, printing, and communications (under estimated cost), and capital expenses (equipment necessary for skills trainings in lieu of pass through funds). Amended 4/8/05. Approved per Susan Thornton phone call 4/12/05.
 3. Funds shifted from 3b personnel to purchase monitoring equipment. Equipment will be used to train volunteers and also for volunteer use. Amended 4/8/05. Approved 4/12/05 via Susan Thornton phone call.
 4. Funds shifted from 3c personnel and travel expenses (over estimates in both categories) to contracts, monitoring programs, printing and communications (under estimated costs), and capital expenses (equipment necessary for skills trainings in lieu of pass through funds). Amended 4/8/05. Approved per Susan Thornton phone call 4/12/05.
 5. Funds shifted from 3b personnel and contract to 3a personnel and contract to eliminate negative balance. Amended 4/8/05. Approved per Susan Thornton phone call 4/12/05. Corrected 6/23/05. \$0.38 shifted from 3b to 3a. Approved 7/7/05 via Susan Thornton email.
 6. Funds shifted from 3b capital expense and 3c development and implementation of skills trainings, direct operating costs, and travel to 3c capital expense to close out categories and provide funds to purchase monitoring equipment. Amended 6/13/06. Approved via Susan Thornton email 6/13/06.

Detailed Budget for Result 4: Healthy Lakes & Rivers (\$50,000 total budget)					
Contract with Initiative Foundation					
2003 LCMR Proposal Budget	1,2,3,4 Budget	Budget Detail	Amount Spent (6/30/06)	Balance (6/30/06)	
Result 4: Volunteer Training	Healthy Lakes and Rivers Training (Initiative Foundation)	Provide leadership training, skills, and technical resources to participants in the Healthy Lakes and Rivers Training to successfully develop and implement a lake or river management plan.			
BUDGET ITEM					TOTAL FOR ITEM
PERSONNEL: Staff Expenses, Wages, salaries & benefits ? Be specific on who is paid \$, to do what?	\$41,953.48	\$6585 for administrative assistant 0.20 FTE for project + 25% fringe benefits; \$12,870 for 0.15 FTE for project + 25% fringe benefits; \$26,239 for 0.50 FTE for project + 25% fringe benefits.	\$41,953.48	\$0.00	\$41,953.48
Development and Implementation of Lake and River Management Plans					
Professional/Technical (with whom?)	\$600.00	Larry Wannebo; training consultant fee to conduct a two-day leadership training workshop for groups prior to writing their lake or river management plans. This will not be continued as services can be provided inhouse.	\$600.00	\$0.00	\$600.00
Equipment					
Analysis (lab + data)					
Communication of information (production, printing etc.)					
Other contracts (with whom?) list out personnel, equipment, etc.					
Space rental: NOT ALLOWED					
Other direct operating costs (for what? ? be specific)	\$2,560.87	Expenses to conduct skills building workshops. : Rent facility for two days of leadership and management plan training (16 hours); training materials (\$21/person X 110-128 people)	\$2,560.87	\$0.00	\$2,560.87
Printing					
Advertising					
Direct Costs: Communications, telephone, mail, general office, etc.	\$1,905.05		\$1,905.05	\$0.00	\$1,905.05
Office Supplies (list specific categories)					
Other Supplies (list specific categories)					
Travel expenses in Minnesota (subcontractor)	\$100.00	Consultant travel for leadership training workshop;	\$100.00	\$0.00	\$100.00
Travel expenses in Minnesota (project staff)	\$2,880.60		\$2,880.60	\$0.00	\$2,880.60
Travel outside Minnesota (where?)					
Tools and equipment (list categories)					
Office equipment: Computer Station					
Other Capital equipment (list specific items)					
COLUMN TOTAL	\$50,000.00		\$50,000.00	\$0.00	\$50,000.00
1. Funds shifted to personnel to cover costs of training events, as addition funds were secured to pay out directly to volunteer groups for implementation. 8/30/04 Approved via email from Susan Thornton dated 9/2/04.					
2. Funds shifted from personnel (\$3000) to travel (\$2000) and expenses and direct costs (\$500 each). With expansion of the program to multiple counties, direct expenses and travel increased significantly. Amended 4/8/05. Approved per phone call from Susan Thornton 4/12/05.					
3. Funds shifted from personnel ((\$2,500) to travel (\$1,500) and direct costs (\$1,000). Due to program expansion geographically, expenses and travel have increased. From this point forward, as funds are spent down, remaining funds in all categories will be shifted as needed to cover final expenses. Amended 3/30/06. Approved per Susan Thornton email 3/31/06					
4. Funds shifted from Skills building (\$639.13) and Direct Costs (\$194.95) and Travel (\$919.40) to personnel (\$1,753.48) to close out all categories. Preapproved via Susan Thornton email 3/31/06. Ammended 7/26/06.					

Appendix B
U of M final report

Result 2: Provide the capability to use remote sensing tools to assess lakes and streams.

Summary Budget Information for Result 2:	\$ 180,000.00
Amount Spent as of 6/30/06	\$ 179,998.28
Balance	\$ 1.72

Completion Date: June 30, 2006

Result Status as of June 30, 2006:

1. Statewide monitoring of lakes by satellite remote sensing

The primary activity this quarter to complete the project has been completion of the processing and classification of the Landsat imagery for 1985, 1995 and 2005. The classifications for 1990 and 2000 were generated from previous projects. Maps of the new classifications of over 10,000 lakes for 1995 and 2005 are shown in Figures 1.1 and 1.2.

We now have a time series of five classifications from 1985 – 2005 available for analysis of spatial and temporal trends. We are confident that no other state has anything comparable in number of years of classifications, number of lakes monitored or geographic coverage. These data provide a statewide census of lake clarity, an indicator of lake quality, for over 10,000 lakes for assessment of the condition of lakes and possible changes over time. Current state monitoring activities are limited to approximately 600 lakes each summer. The essence of our approach is to use those data to classify the Landsat satellite data for all lakes larger than 20 acres in size. The satellite data provide an economical way to extend (but not replace) the conventional lake monitoring activities to all lakes.

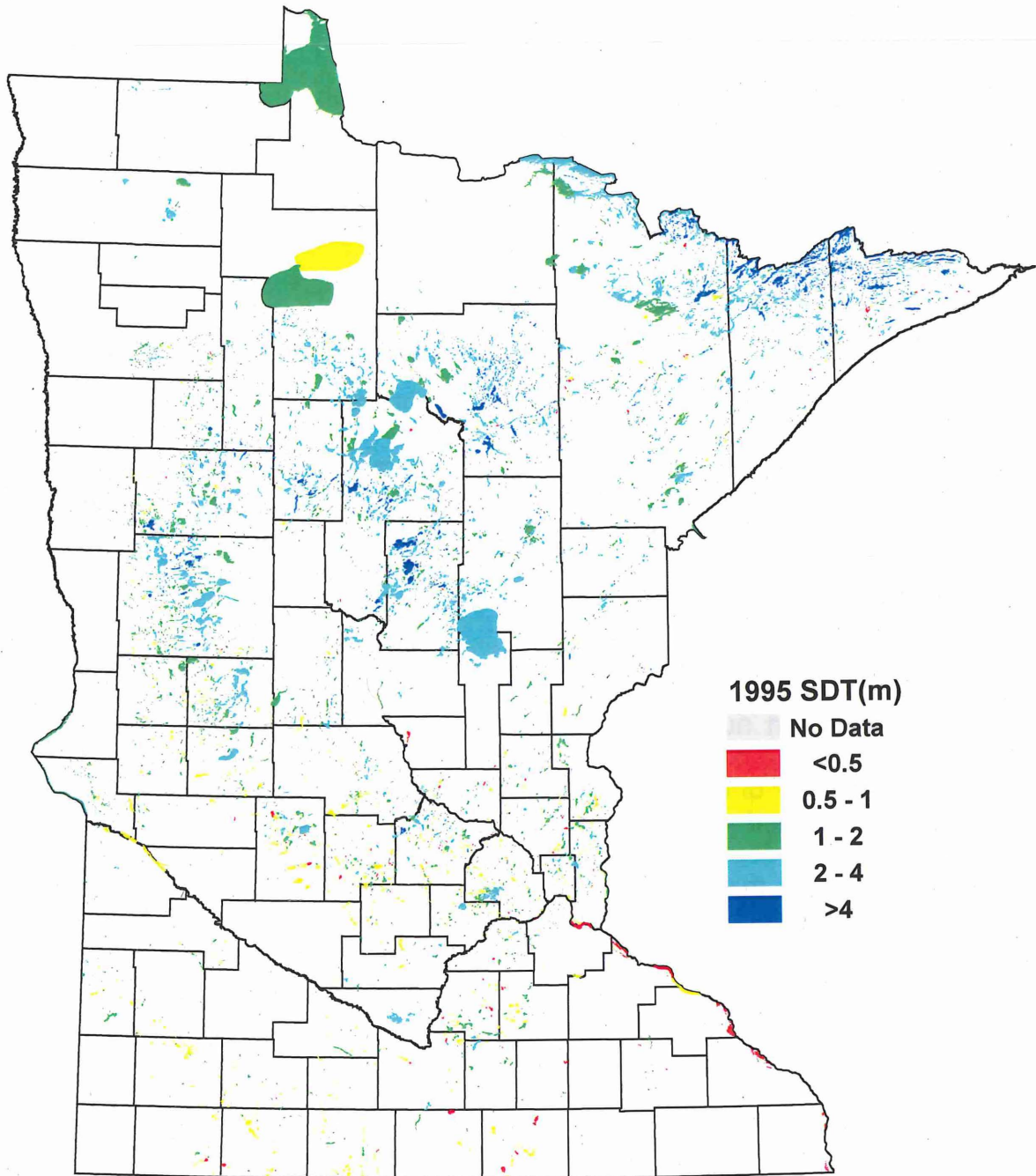


Figure 1.1. Lake clarity classification of ~1995 Landsat data.

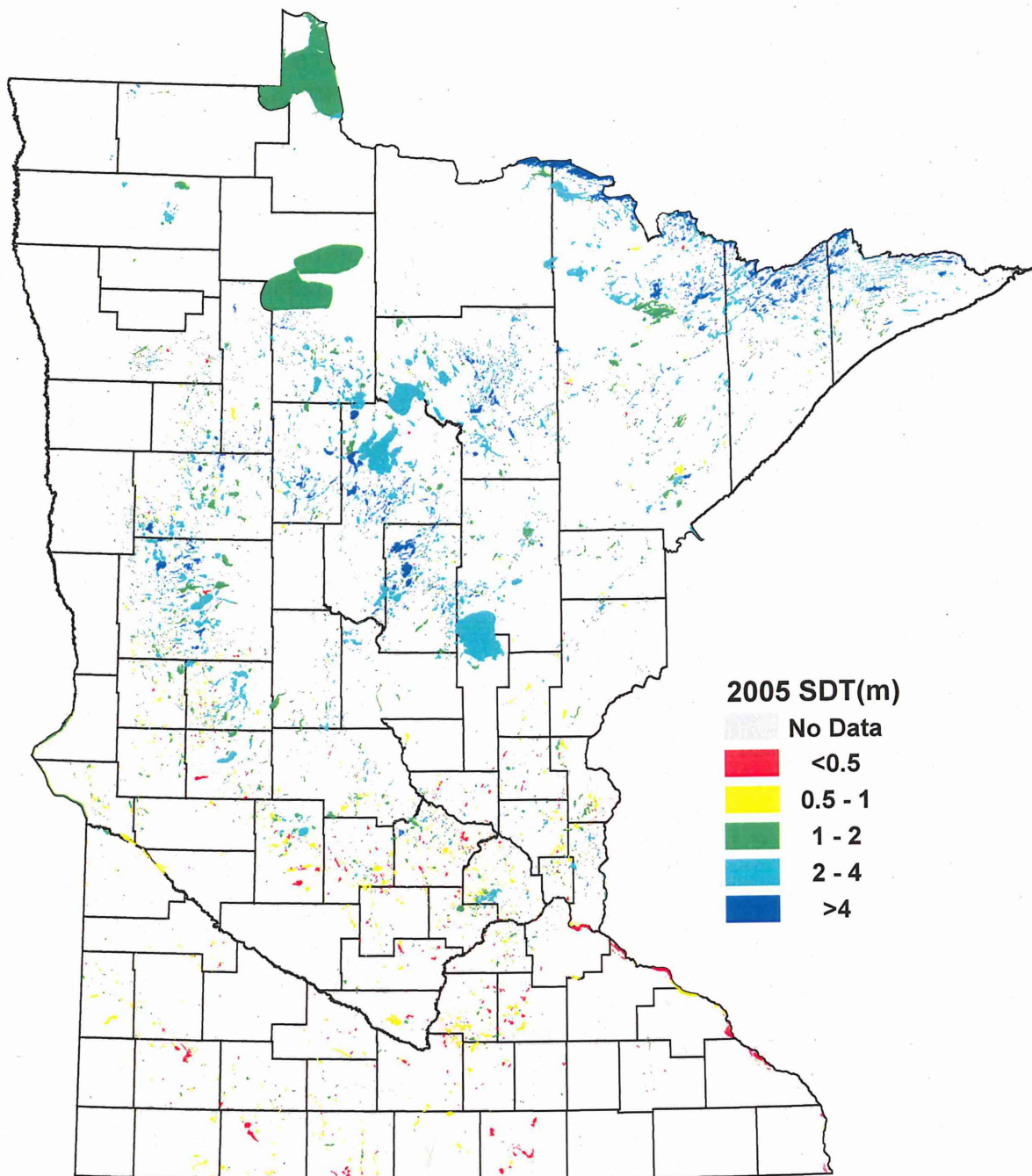


Figure 1.2. Lake clarity classification of ~2005 Landsat data.

Analysis of Trends and Geographic Patterns

With the statewide classifications of lake clarity over a 20-year period we have the data for analysis of temporal trends and geographic patterns. These analyses have been initiated with statistical analysis of the 1990 and 2000 classifications, and will be expanded and extended to the additional years.

The general statistical patterns of water clarity in Minnesota lakes did not change dramatically between 1990 and 2005. The statewide compilation in Figure 1.3 shows there were slightly fewer lakes in the highest clarity class (greater than 4 meters [\sim 13 feet]) in 1995 and 2000 than in 1990 and 2005 and slightly more lakes in the lowest clarity class (less than 0.5 m [\sim 1.6 feet]). However, the median water clarity of 2.15 m for all lakes in 2000 was slightly higher than the 2.00 m in 1990. The lower bar graphs in Figure 1.4 show that there was a more gradual tailing off of water clarity values in the 1990 census than in 2000.

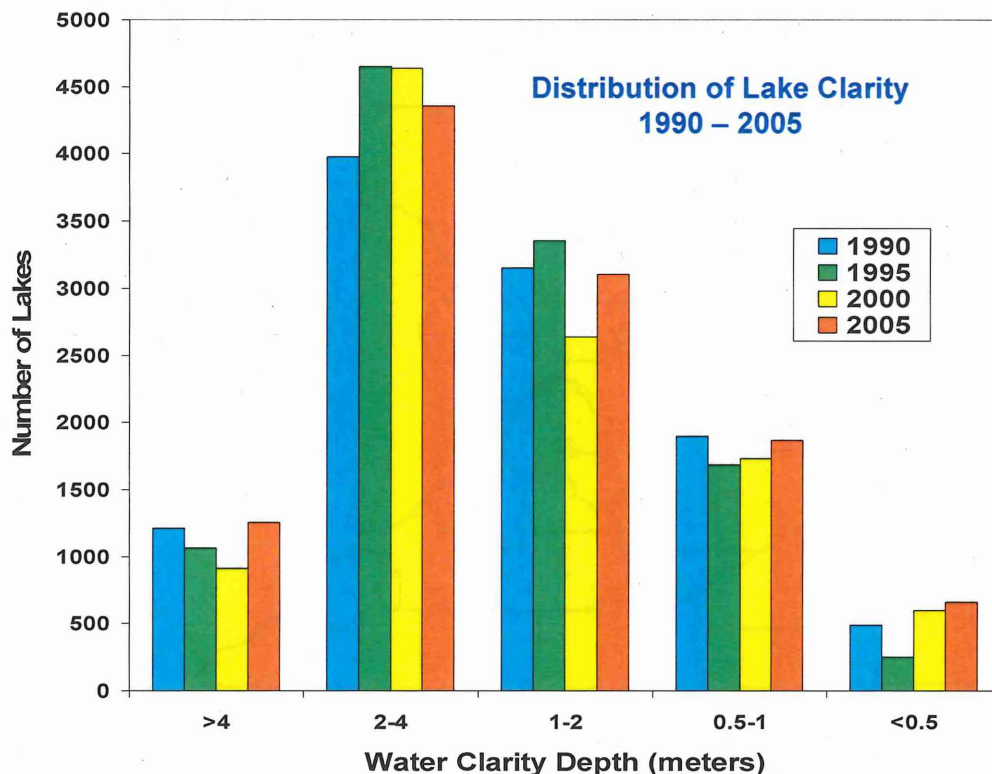


Figure 1.3. Distribution of lake clarity in Minnesota at five-year intervals from 1990 to 2005.

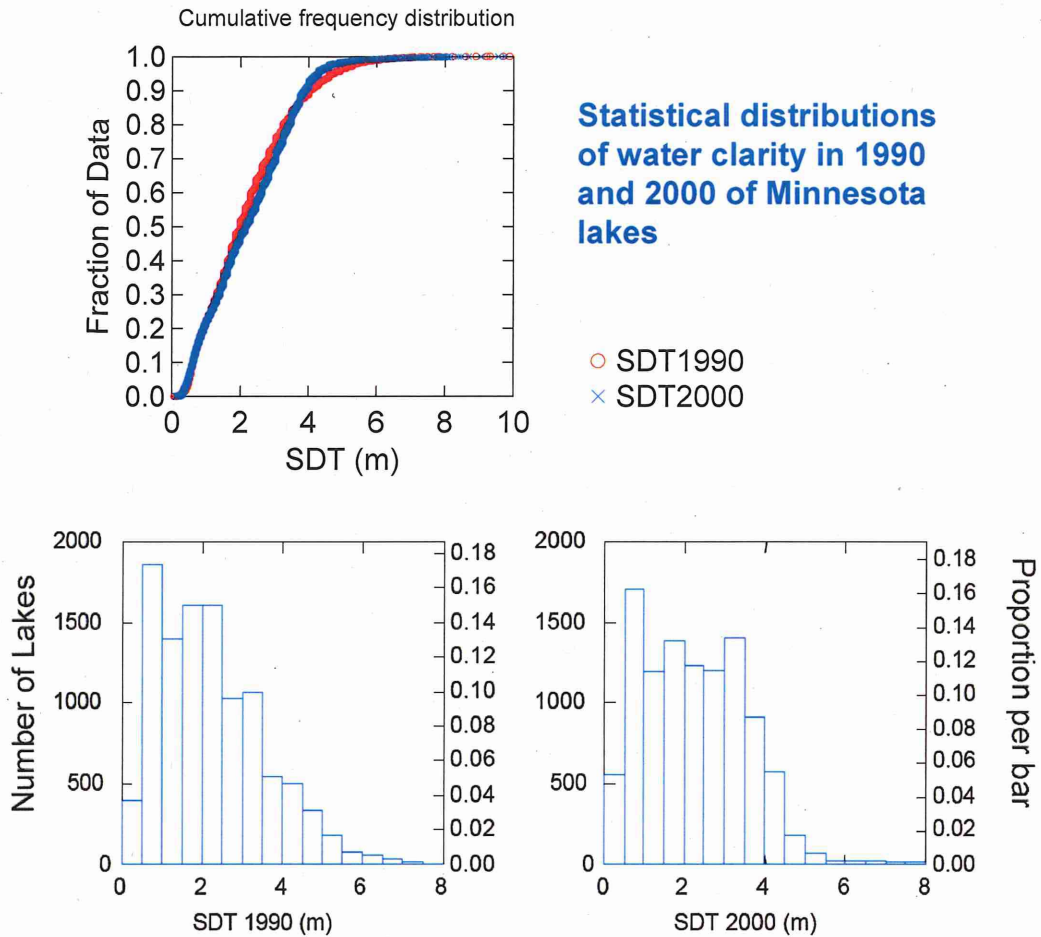


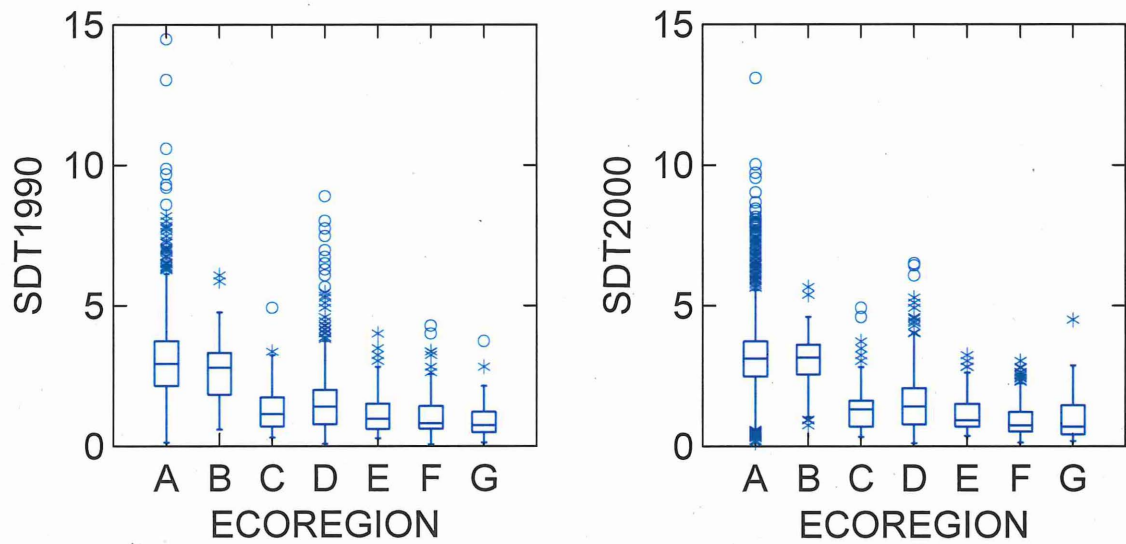
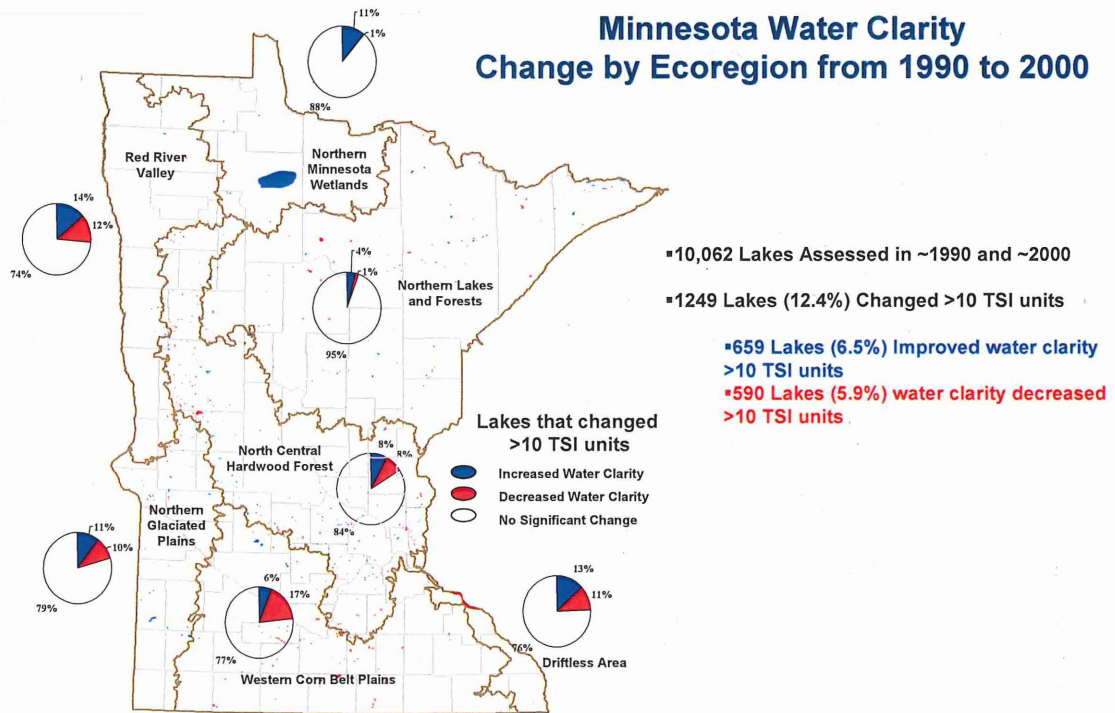
Figure 1.4. Statistical distributions of water clarity in 1990 and 2000 of Minnesota lakes.

As shown in Figure 1.5 water clarity in Minnesota lakes varies in generally predictable patterns by ecoregion, with the highest clarity in the northeastern region (Northern Lakes and Forests) and lowest clarity in the southern and southwest regions (Driftless Area, Western Corn Belt Plains and Northern Glaciated Plains).

Only about 12 percent of Minnesota lakes exhibited a large change in water clarity between 1990 and 2000, and about half of them had improved clarity while the other half showed decreased clarity (Figure 1.5).

Variations in ecoregion distributions of lake clarity clearly reflect land-use and land cover conditions. Lakes in the Northern Lakes and Forest Ecoregion, which has only 6% agricultural land and is dominated by deciduous and conifer forest, have much higher water clarity than lakes of the Northern Central Hardwood Forest ecoregion, in which agricultural land constitutes 50% of the region (Figure 1.6).

Minnesota Water Clarity Change by Ecoregion from 1990 to 2000

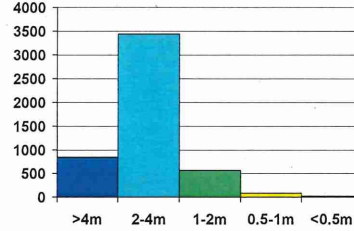
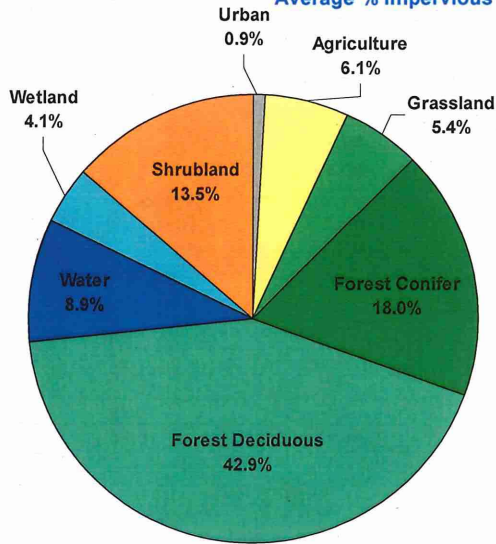


A = Northern Lakes and Forests; B = Northern Minnesota Wetlands; C = Red River Valley; D = North Central Hardwood Forest; E = Northern Glaciated Plains; F = Western Corn Belt Plains; G = Driftless Area

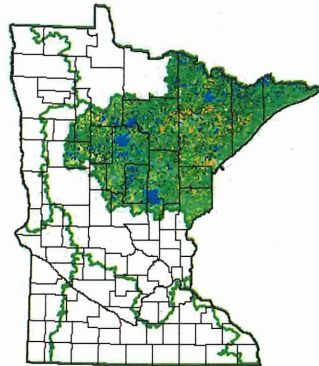
Figure 1.5. Minnesota water clarity by ecoregion from 1990 to 2000.

Northern Lakes and Forests Ecoregion
Water Clarity and Land Cover Statistics

Average % Impervious = 29.4



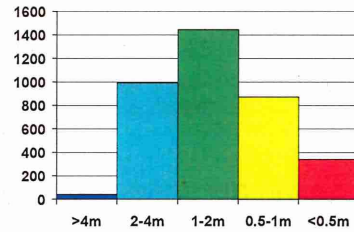
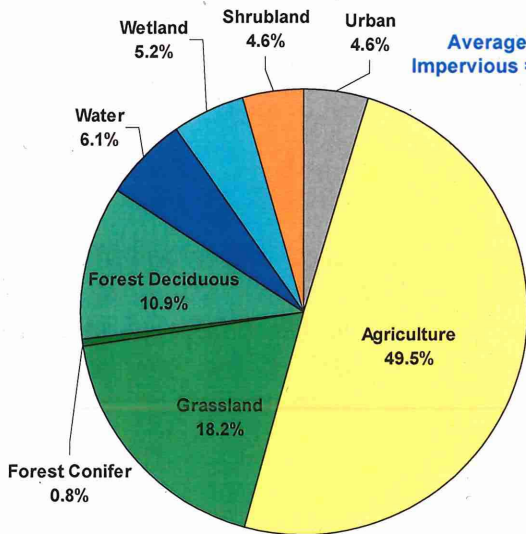
NLF	~1990	~2000
Average SDT(m)	3.05	3.12
Min SDT(m)	0.14	0.15
Max SDT(m)	14.49	13.10
Standard Deviation	1.29	1.09



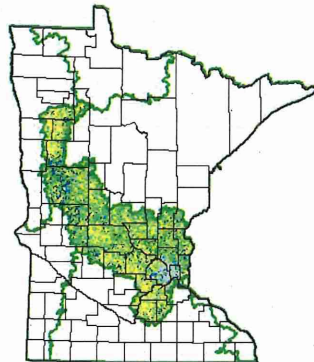
Population per square mile = 17
 Drainage Ditch miles per sq. mile = 0.089

North Central Hardwood Forests Ecoregion
Water Clarity and Land Cover Statistics

Average % Impervious = 40.4



NCHF	~1990	~2000
Average SDT(m)	1.51	1.54
Min SDT(m)	0.09	0.12
Max SDT(m)	8.90	6.51
Standard Deviation	0.91	0.90



Population per square mile = 141
 Drainage Ditch miles per sq. mile = 0.201

Figure 1.6. Summary water clarity and land cover statistics for the Northern Lakes and Forests and North Central Hardwood Forests Ecogregions.

Agricultural land uses dominate the Western Corn Belt Plains Ecoregion, and most of the lakes in this region have low water clarity (less than 1 m [3.3 ft]) (Figure 1.7).

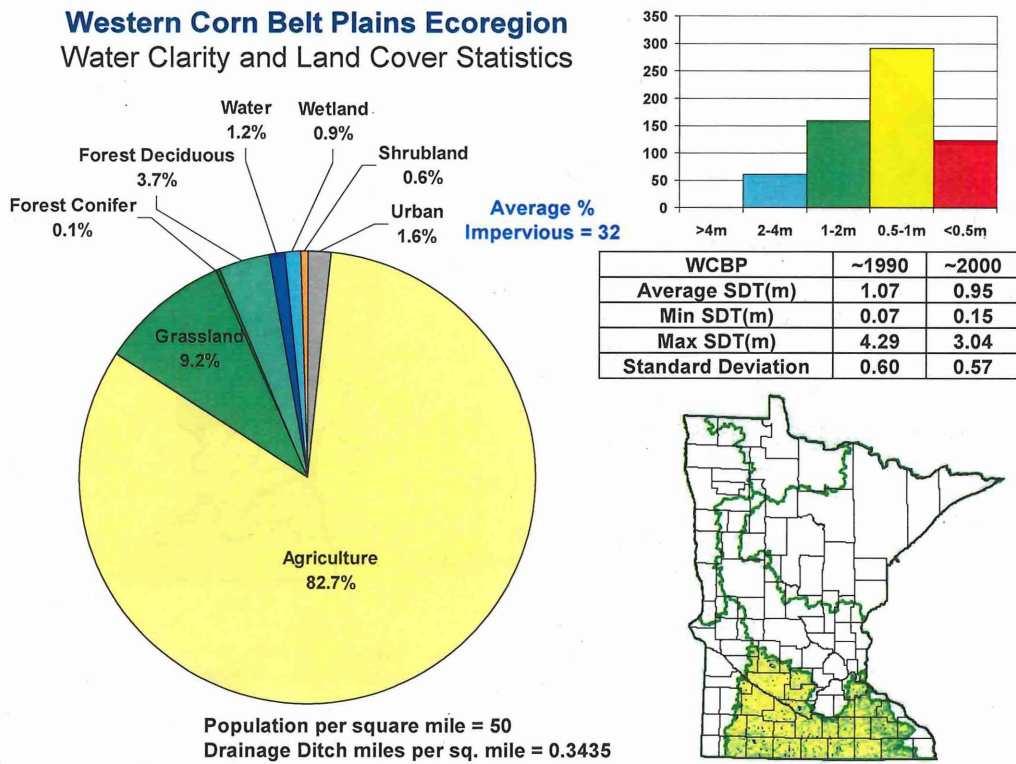
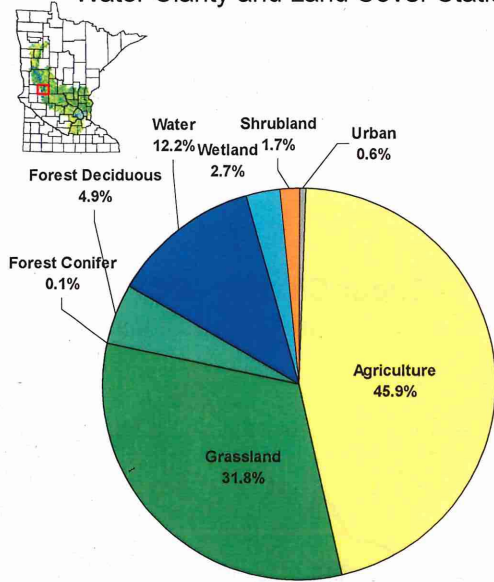


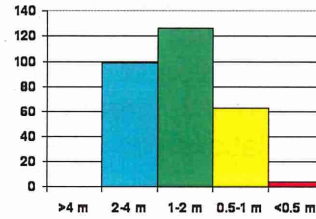
Figure 1.7. Summary water clarity and land cover statistics for the Western Corn Belt Ecoregion.

Land-use characteristics and lake water clarity data also are available on a county-by-county basis. Examples of the county data are shown in Figure 1.8 for Douglas and LeSeur Counties. Note the very low water clarity of lakes in LeSeuer County, in which agriculture accounts for 73% of the land area. In contrast, lake clarity is higher in Douglas County, in which agriculture accounts for less than 50 percent of the land area.

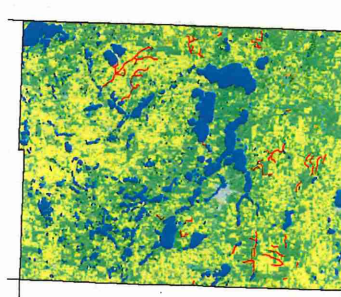
Douglas County - NCHF Ecoregion
Water Clarity and Land Cover Statistics



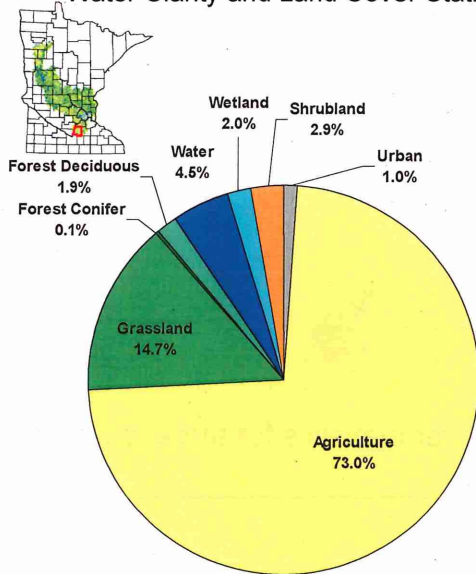
Population per square mile = 51.8
Drainage Ditch miles per sq. mile = 0.09



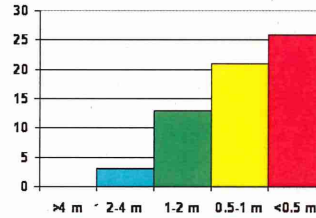
Douglas	~1990	~2000
Average SDT(m)	1.42	1.72
Min SDT(m)	0.31	0.38
Max SDT(m)	3.70	3.88
Standard Deviation	0.74	0.79



LeSueur County - NCHF Ecoregion
Water Clarity and Land Cover Statistics



Population per square mile = 56.7
Drainage Ditch miles per sq. mile = 0.48



LeSueur	~1990	~2000
Average SDT(m)	1.15	0.81
Min SDT(m)	38	0.22
Max SDT(m)	4.01	2.68
Standard Deviation	0.66	0.59

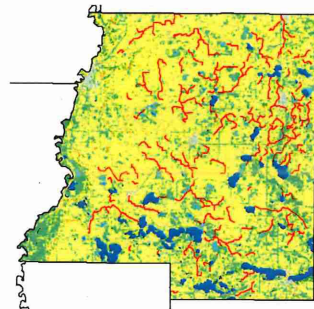


Figure 1.8. Water clarity and land cover statistics for Douglas and LeSueur Counties.

Of greatest interest from both scientific and management perspectives is the relationship between lake water clarity and land use within a lake's catchment area (or watershed). Figure 1.9 illustrates patterns for three small lakesheds in LeSueur County. Delineation of watersheds for all lakes in Minnesota soon will become a reality, and will greatly enhance our ability to make quantitative assessments of relationships between lake conditions and watershed characteristics.

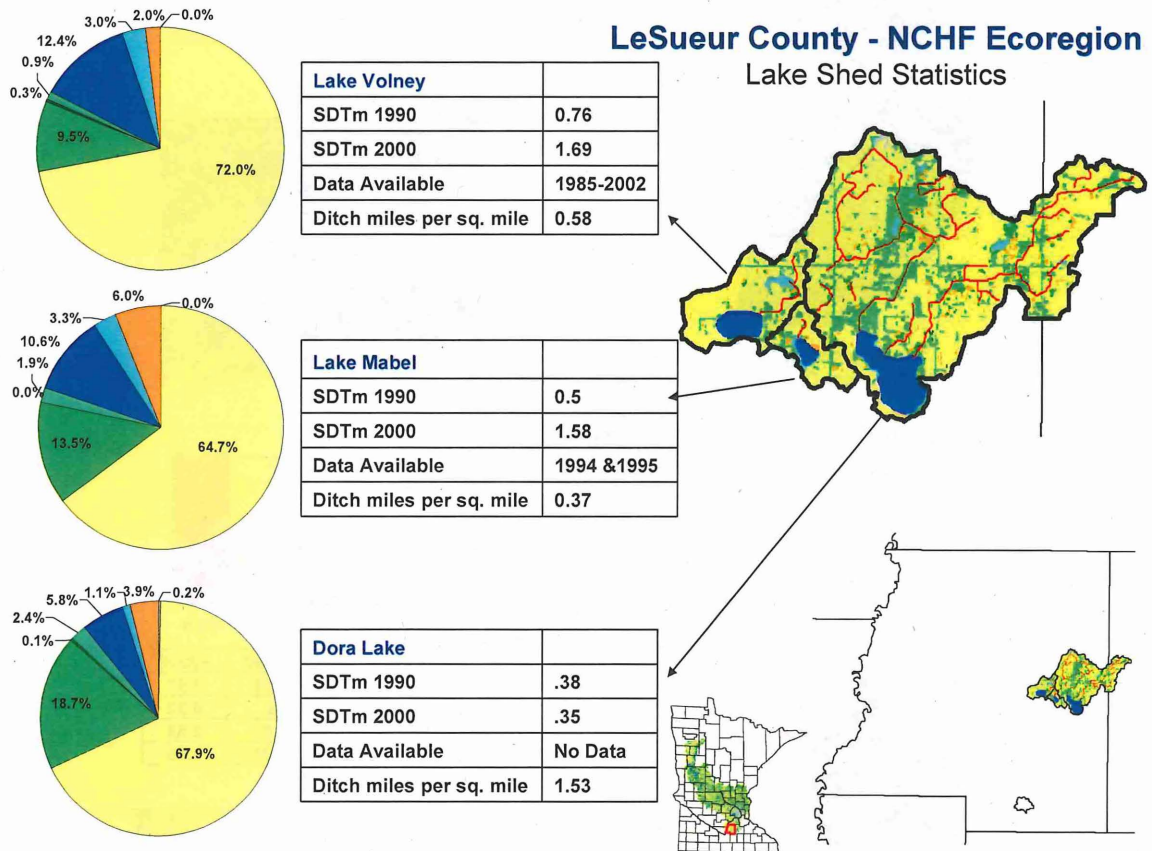


Figure 1.9. Example of water clarity and land cover statistics for three lakesheds in LeSueur County.

Effects of Humic Color on Estimation and Mapping of Lake Water Properties

Ground-based measurements on 15 Minnesota lakes with wide ranges of optical properties and Landsat TM data from the same lakes were used to evaluate the effect of humic color on satellite-inferred water quality conditions. Color (C_{440}), as measured by absorbance at 440 nm, causes only small biases in estimates of Secchi disk transparency (SDT) from Landsat TM data, except at very high values ($> \sim 300$ chlorophyllate units) (Figure 1.10).

Similarly, when chlorophyll *a* (chl *a*) levels are moderate or high ($> 10 \mu\text{g/L}$), low-to-moderate levels of humic color have only a small influence on the relationship between SDT and chl *a* concentration, but it has a pronounced influence at high levels of C_{440} (e.g., $> \sim 200$ CPU). However, deviations from the general chl *a*-SDT relationship occur at much lower C_{440} values (~ 60 CPU) when chl *a* levels are low.

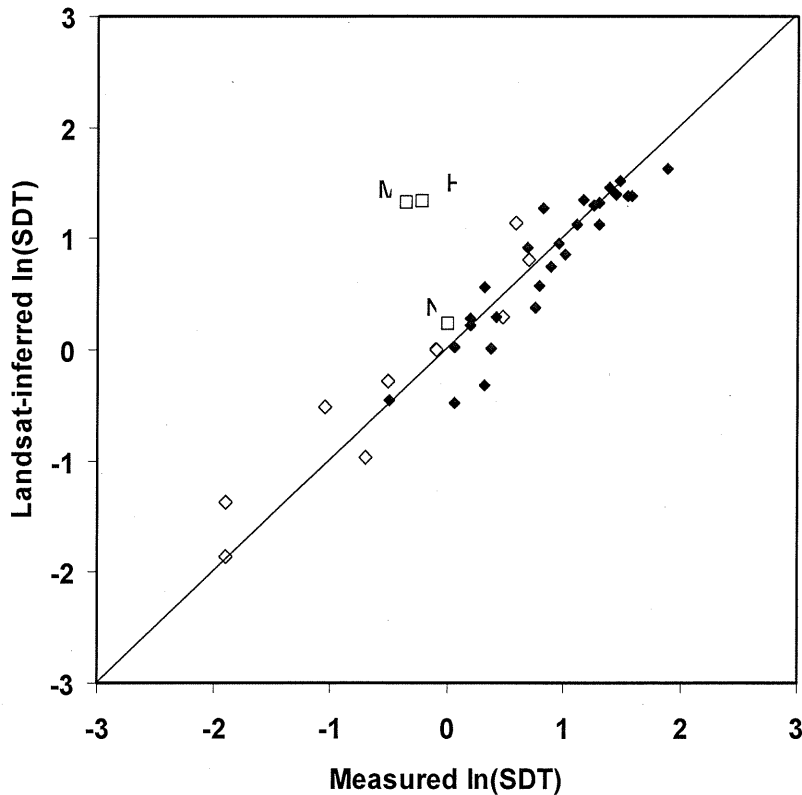


Figure 1.10. Natural log of Landsat-inferred SDT for lakes in east-central Minnesota versus natural log of measured SDT. Closed diamonds: low color lakes; open diamonds: moderate color lakes; open squares: high color lakes; M = Munson; H = Hizer; N = Net.

Good statistical relationships were found between optical properties of lake water generally associated with algal abundance (SDT, chl *a*, turbidity) and measured brightness of various Landsat TM bands. The best relationships for chl *a* (based on R^2 and absence of statistical outliers or lakes with large leverage) were combinations of bands 1, 2, or 4 with the band ratio 1:3 ($R^2 = 0.88$; Table 1)). Although TM bands 1-4 individually or as simple ratios were poor predictors of C_{440} , multiple regression analyses between $\ln(C_{440})$ and combinations of bands 1-4 and band ratios (Table 2) yielded several relationships with $R^2 \geq 0.70$, suggesting that C_{440} can be estimated with fair reliability from Landsat TM data.

Table 1. Coefficients for multiple linear regressions of $\ln(\text{chl } a)$ versus Landsat TM brightness ($\ln(\text{chl } a) = A_0 + A_1\text{Var}_1 + A_2\text{Var}_2$). Only results with $R^2 \geq 0.8$ are shown ($n = 15$).

Var ₁	Var ₂	A ₀	A ₁	A ₂	R ²
TM1	TM1:TM2	21.79	-0.1675	-3.855	0.86
TM1	TM1:TM3	6.71	0.0537	-1.559	0.88
TM2	TM1:TM2	17.31	-0.1485	-4.017	0.85
TM2	TM2:TM3	7.86	0.0572	-1.481	0.88
TM3	TM1:TM2	10.60	0.0289	-2.633	0.85*
TM3	TM1:TM3	12.55	-0.0959	-2.179	0.89*
TM4	TM1:TM2	10.78	0.0284	-2.648	0.85
TM4	TM1:TM3	9.46	0.0078	-1.680	0.88

*Lake Typo had a large leverage on the regression

Table 2. Coefficients for multiple linear regressions of $\ln(C_{440})$ versus Landsat TM brightness ($\ln(C_{440}) = A_0 + A_1\text{Var}_1 + A_2\text{Var}_2$). Only results with $R^2 \geq 0.6$ are shown ($n = 15$).

Var ₁	Var ₂	A ₀	A ₁	A ₂	R ²	Comments*
TM1	TM3	23.59	-0.5735	0.430	0.60	Francis = O; Typo = LL
TM1	TM4	21.66	-0.4706	0.352	0.63	Grindstone = O
TM1	TM1:TM4	23.65	-0.3528	-0.657	0.77	Grindstone = O
TM1	TM2:TM3	19.42	-0.1642	-6.441	0.64	
TM1	TM2:TM4	16.04	-0.1829	-1.846	0.70	Grindstone = O
TM2	TM1:TM4	14.78	-0.3485	-0.812	0.75	Grindstone = O
TM2	TM2:TM4	10.45	-0.1412	-1.905	0.63	Grindstone = O
TM4	TM2:TM4	12.07	-0.2145	-2.870	0.70	Grindstone = O; Sturgeon = LL

*O = outlier; LL lake had large leverage in the regression.

In addition, detailed reflectance spectra from the water surfaces of 15 lakes in east-central Minnesota showed patterns related to chlorophyll *a* (chl *a*), turbidity and humic matter (colored dissolved organic matter, CDOM). Increasing chl *a* and turbidity generally resulted in higher reflectance across the visible and near-infrared spectrum. Increasing CDOM led to low reflectance, especially below ~500 nm. Spectra of lakes with high chl *a* were distinguishable from those of lakes low in chl *a*, and lakes with low or high CDOM had readily distinguishable spectra (see Figure 1.11).

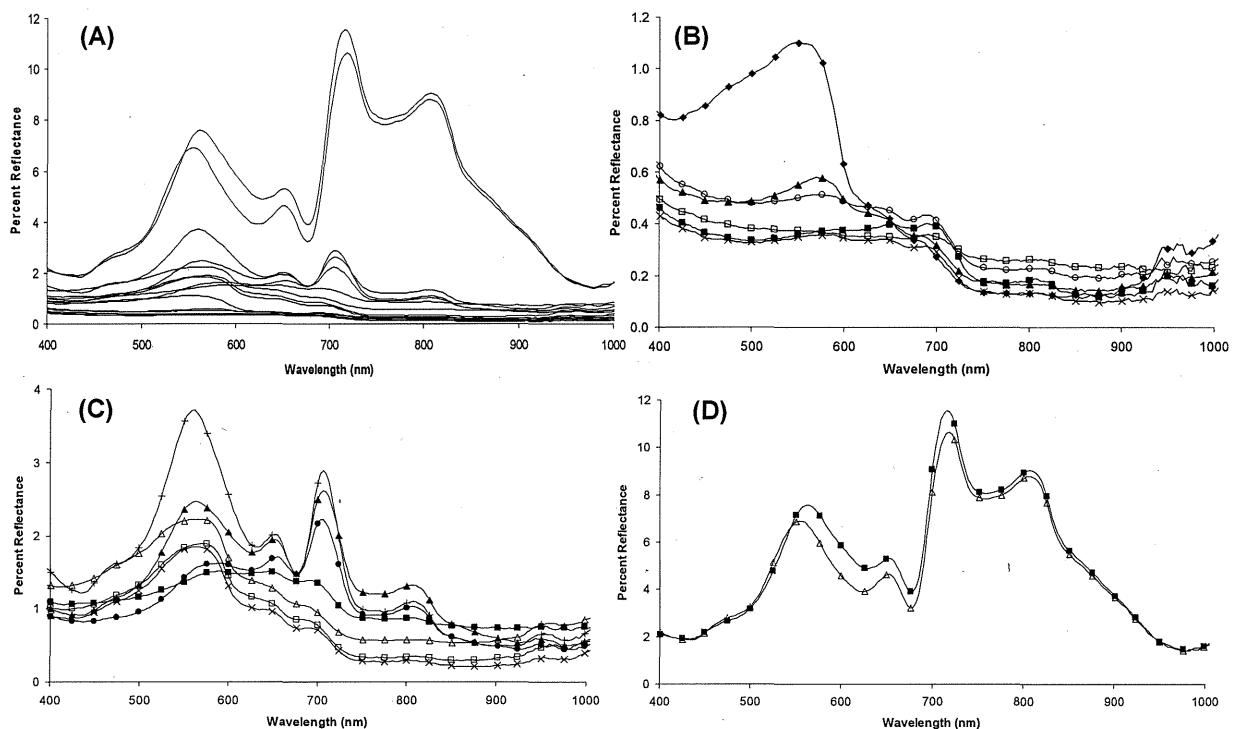


Figure 1.11. (A) Reflectance spectra for 15 lakes in east-central Minnesota; (B) (top right) spectra for the six low-reflectance lakes: Square, \blacklozenge ; Razor, \blacktriangle ; Rock, \circ ; Stevens, \square ; Net, \blacksquare ; Hanging Horn, \times , all of which except Square had relatively low chlorophyll and high humic color; (C) spectra for the seven moderate reflectance lakes: Nokomis, $+$; Cross \blacktriangle ; Harriet, \triangle ; Cedar, \square ; Calhoun, \times ; Grace, \bullet ; Rock, \blacksquare , which had varying levels of color and chlorophyll; (D) (bottom right) spectra for the two high reflectance lakes: Francis, \triangle ; Typo, \blacksquare , both of which had very high chlorophyll and algal turbidity. Note different scales for the plots. Symbols added to distinguish spectra and represent only selected data points.

The field data for the two studies were acquired under a separate contract with the Minnesota DNR, but analyzed as part of the LCMR project. Complete results of the research on the effects of humic color and relationships to chlorophyll are in two papers published in *Lake and Reservoir Management*.

Classification of Large Lakes with MODIS Data

The newer satellite sensor, MODIS, provides ability to assess water clarity and chlorophyll levels in large lakes. Although its coarse spatial resolution (1000 meters) limits its applicability to approximately 100 large lakes in Minnesota, its advantages of daily overpasses and a much larger number of spectral bands, including some that can be used to correct for atmospheric effects, make it the satellite sensor of choice for future monitoring of large lakes.

Example classification results for a MODIS image are shown in Figure 1.12. Note the large differences in water clarity between Upper and Lower Red Lake and the gradient of water clarity across Upper Red Lake on the day of image acquisition.

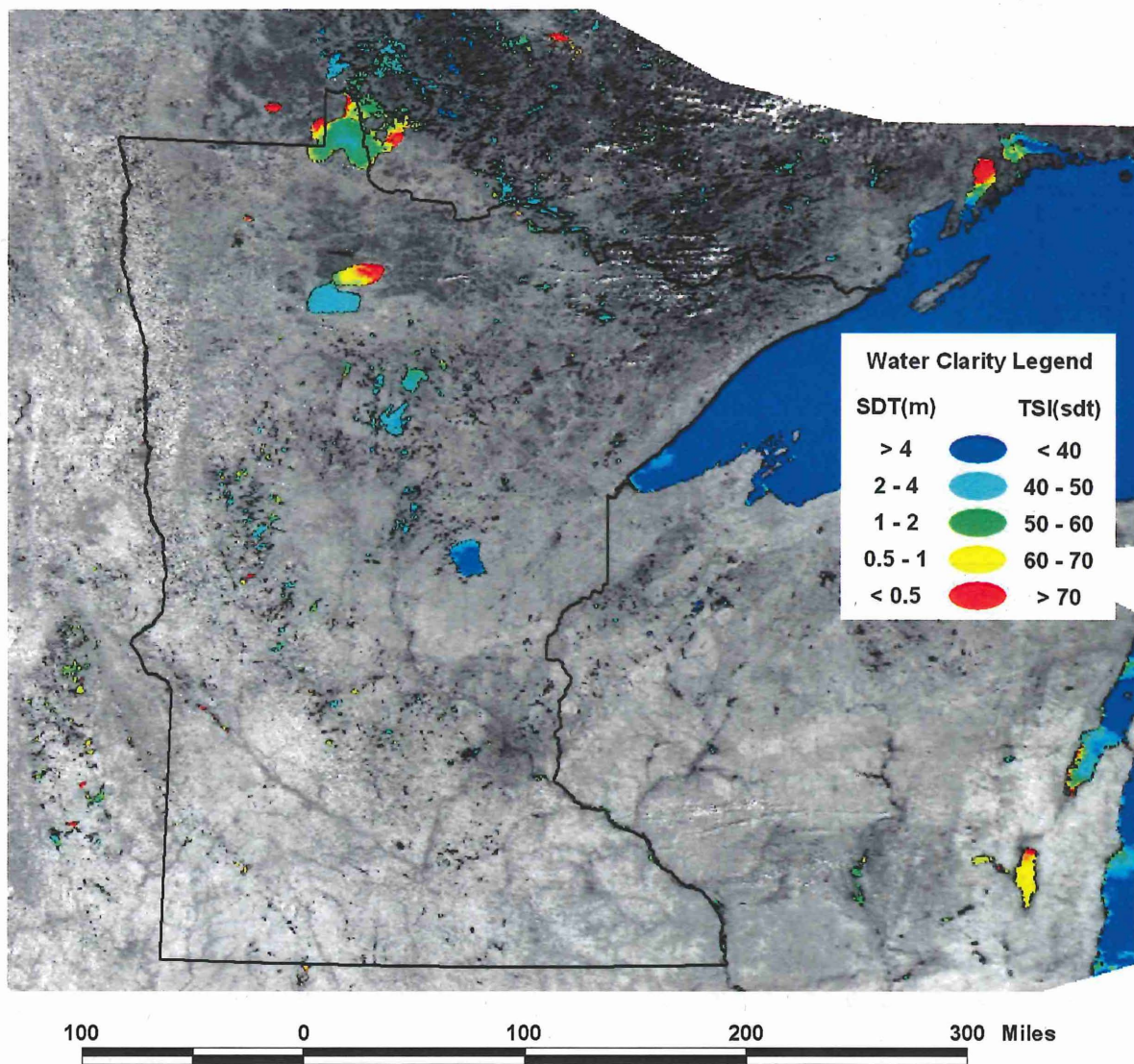


Figure 1.12. Example of lake clarity classification of MODIS 1000-meter resolution image for August 23, 2003

Webpage and Minnesota LakeBrowser

Our webpage, water.umn.edu, describes the methods we use for monitoring lakes and streams and summarizes key results. It features the LakeBrowser a web-based mapping tool that enables users to search for lakes of particular interest, or for lakes that have less than or greater than a specified clarity for either the entire state or the area of interest displayed. The LakeBrowser is linked to the DNR Lake Finder website includes additional data and information on lakes. Over the past year the number of visits has averaged 27,000 per month with 85% to the LakeBrowser.

The LakeBrowser database currently includes the data for over 10,000 lakes for 1990 and 2000. We will shortly be adding the new data for 1985, 1995, and 2005, giving users the ability to review the history of lake water quality for five times over the past 20 years.

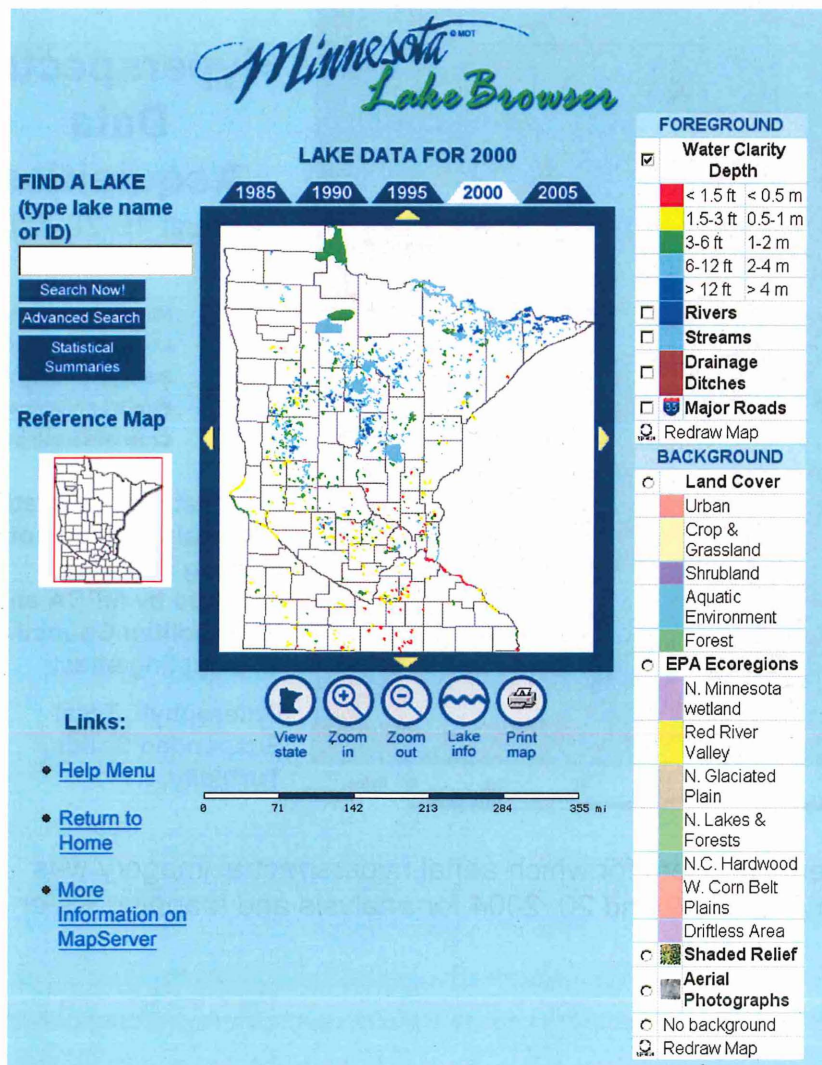


Figure 1.13. Minnesota LakeBrowser homepage.

2. Evaluation of remote sensing technology for monitoring streams

To assess and monitor river and stream properties, higher spatial resolution imagery than the 30-meter Landsat imagery used for lake clarity classification. In addition, if we are to monitor more than water clarity, additional and narrower specific spectral bands that are more strongly related to water properties are needed. To evaluate the potential of remote sensing for monitoring streams we contracted for acquisition of aerial hyperspectral imagery. Imagery was acquired on four river segments shown in Figure 2.1 on August 19-20, 2004.

On the same days samples for measurements of several important water properties, including transparency, turbidity, total suspended sediments and chlorophyll a, b, and c were acquired by the Minnesota Pollution Control Agency, Department of Natural Resources, Metropolitan Council, and the University, were acquired for 37 sample sites at strategic points along the streams.

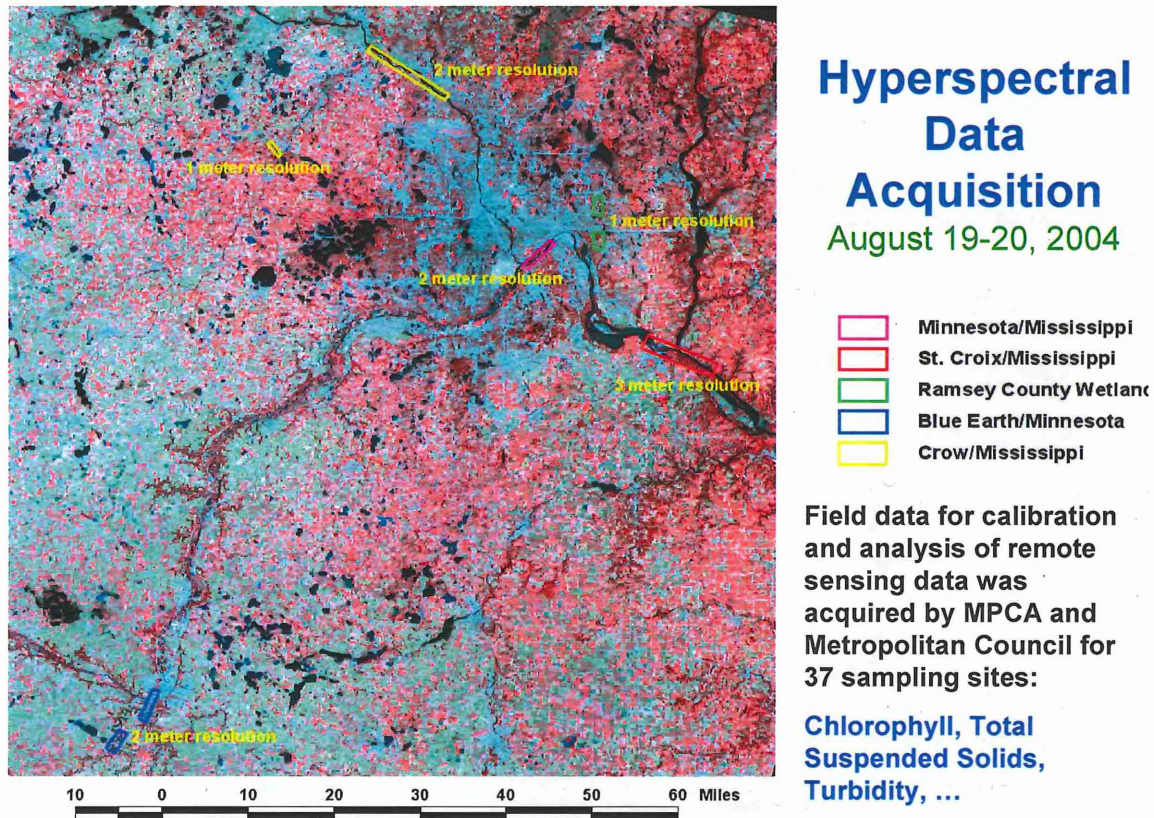


Figure 2.1. Segments of rivers for which aerial hyperspectral imagery was acquired on August 19 and 20, 2004 for analysis and mapping water properties.

The spectral reflectance spectra for the sample sites are shown in Figure 2.2. There is considerable variation in the reflectances among the different rivers and sites. Our analyses of the imagery and the relationships of spectral reflectance to the biophysical water properties indicate strong relationships, with R^2 values ranging from 0.53 to 0.94. Regression models of these relationships have been used to map the various water properties, providing information on their spatial patterns. An example of the model for one of the variables, transparency (t-tube), is shown in Figure 2.3.

The essence of the approach is that once the relationship is modeled, the independent variable, e.g. transparency, can be estimated for each pixel in the imagery. Figures 2.4 and 2.5 show the spatial patterns in transparency for several of the river segments, while Figure 2.6 shows maps of the classifications for additional river variables for the St. Croix and Mississippi Rivers. The maps show the complex patterns and interactions of sediment and chlorophyll in these river segments.

The results indicate that it is possible with the right remote sensing data, namely high spatial and spectral resolution imagery, to accurately map key water quality properties. With additional statistical analysis that will be completed as part of the continuing 2005 LCMR project, we anticipate developing improved models for these variables, as well as for other water quality variables.

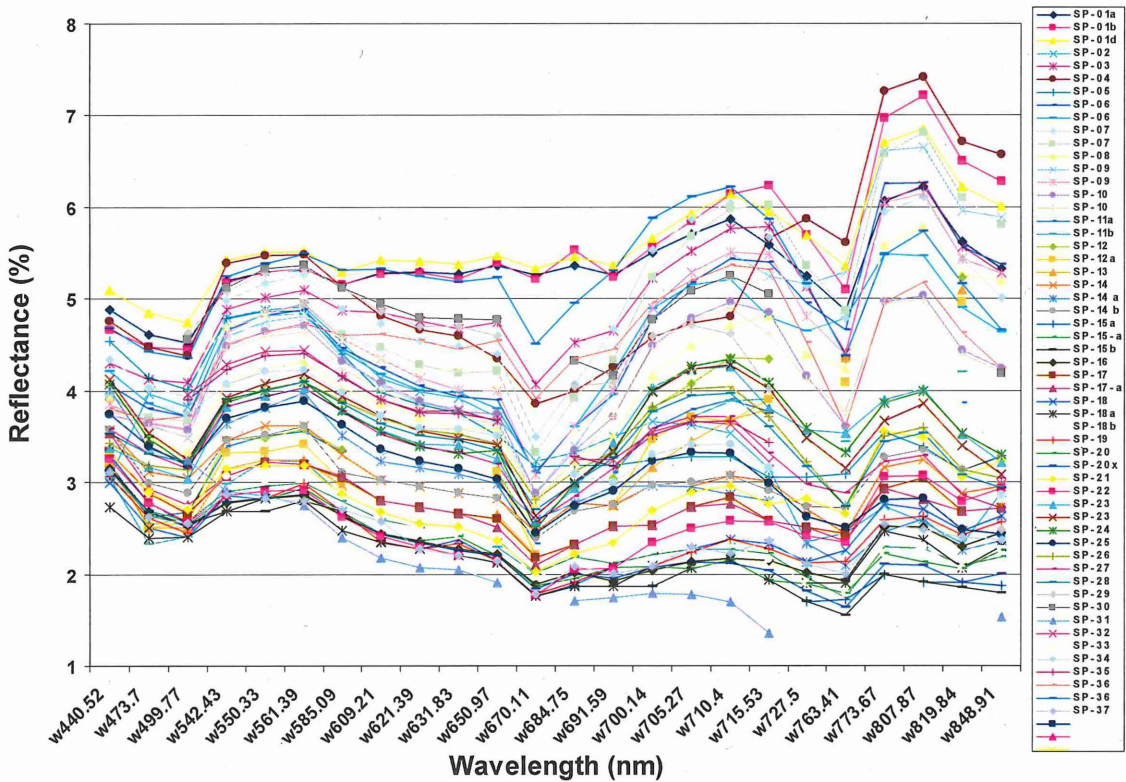


Figure 2.2. Spectral reflectance data for the river sample locations.

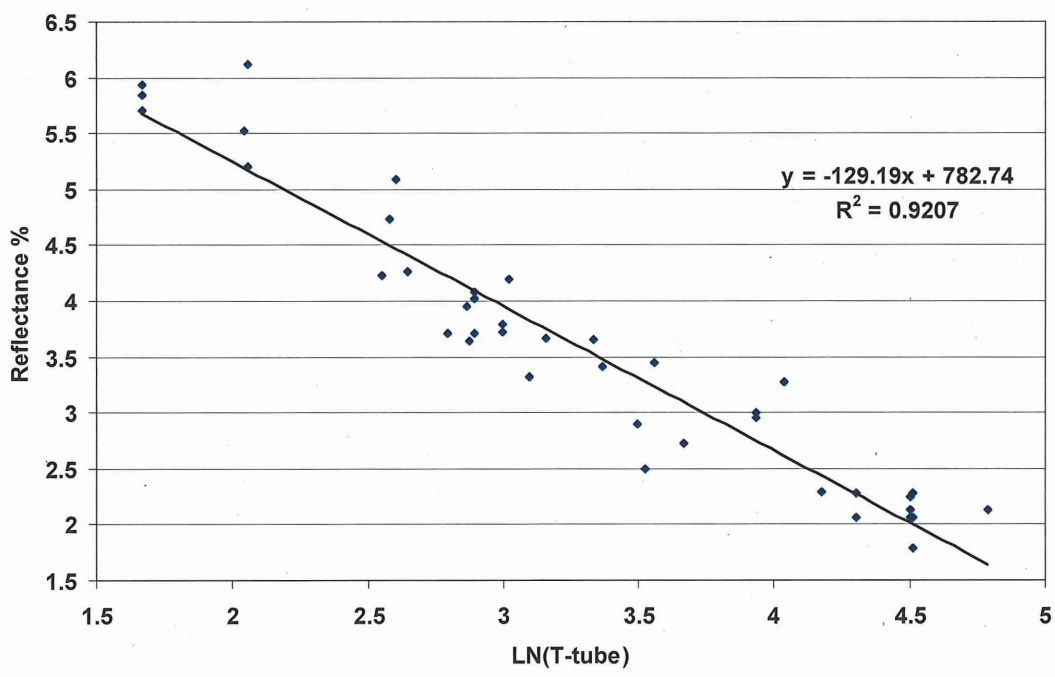
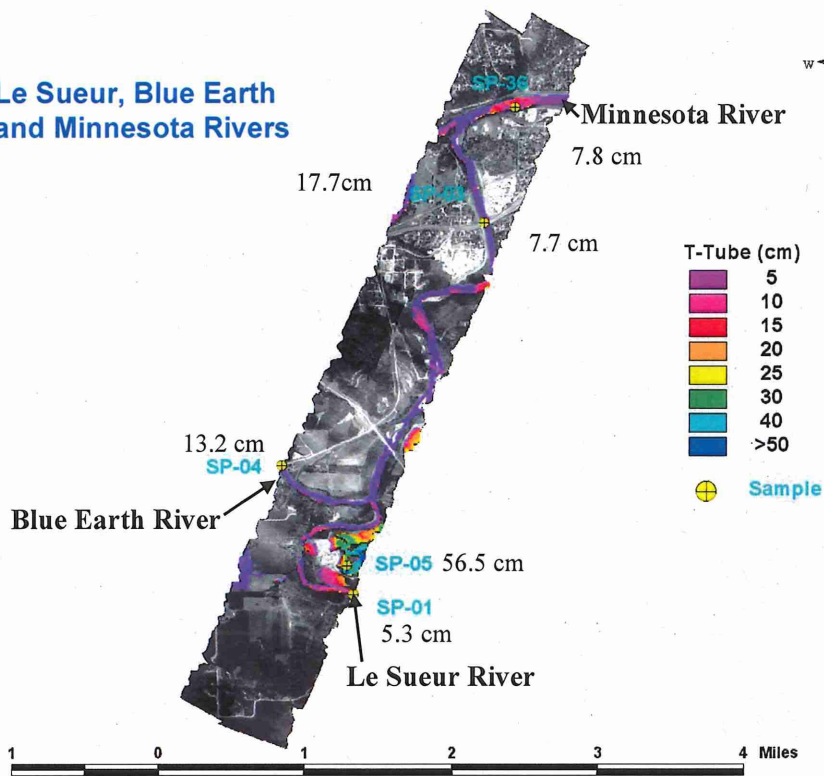


Figure 2.3. Example of the relationship of one of spectral reflectance and one of the river water characteristics, t-tube transparency.

Le Sueur, Blue Earth and Minnesota Rivers



Confluence of Minnesota and Mississippi Rivers

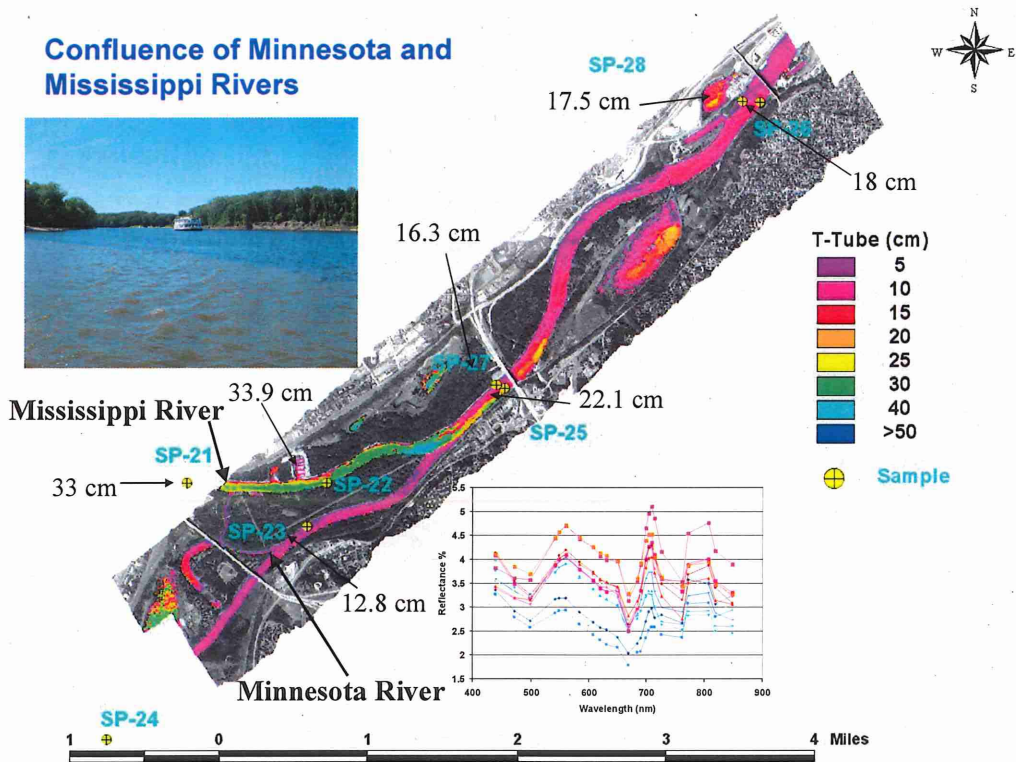


Figure 2.4. Classifications of t-tube transparency for the Blue Earth (top) and Minnesota – Mississippi (bottom) Rivers.

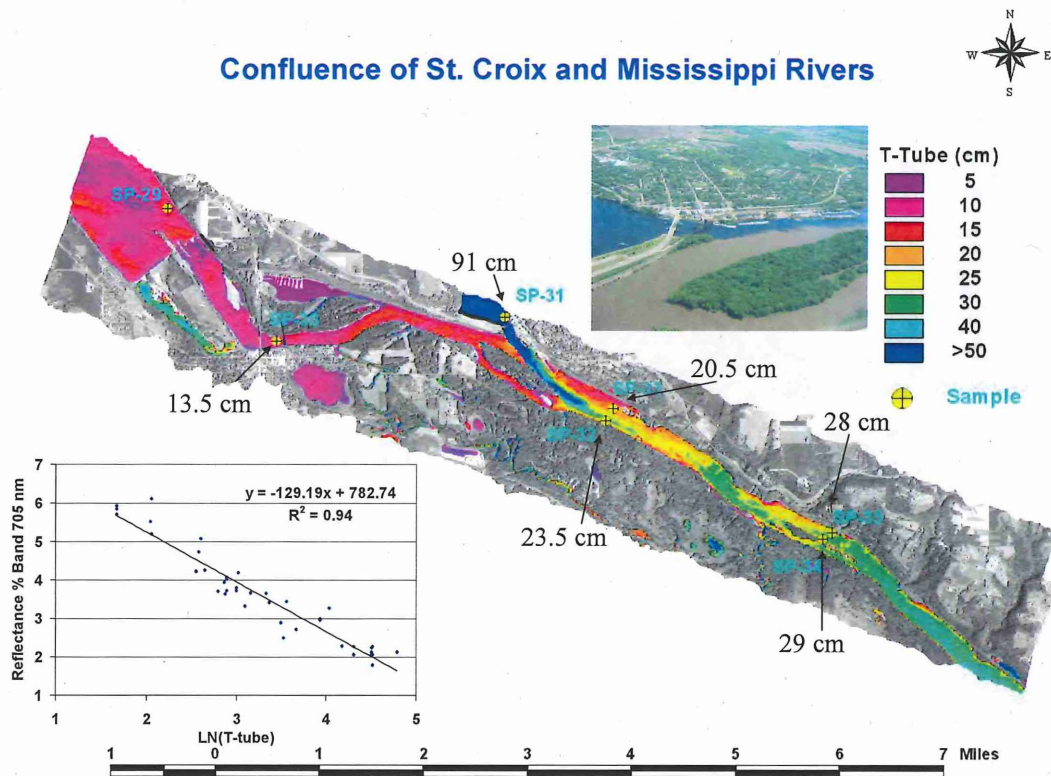
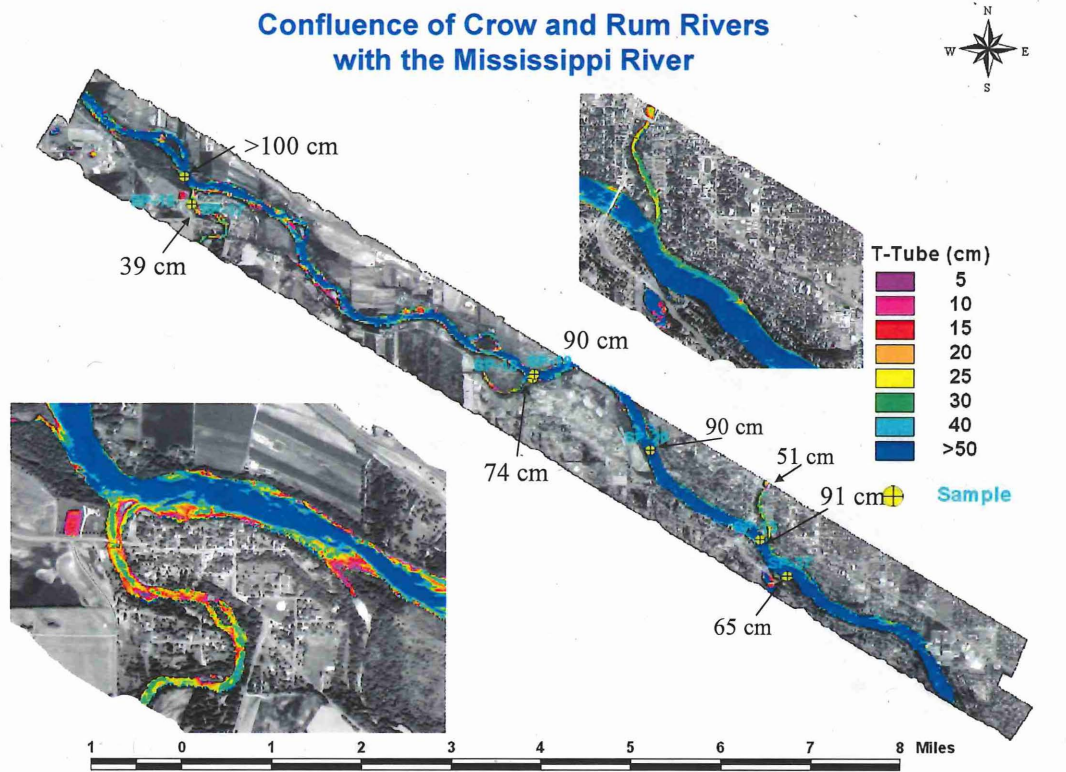


Figure 2.5. Classifications of t-tube transparency for the Crow, Rum and Mississippi (top) and St. Croix and Mississippi (bottom) Rivers.

Confluence of the St. Croix River with the Mississippi River

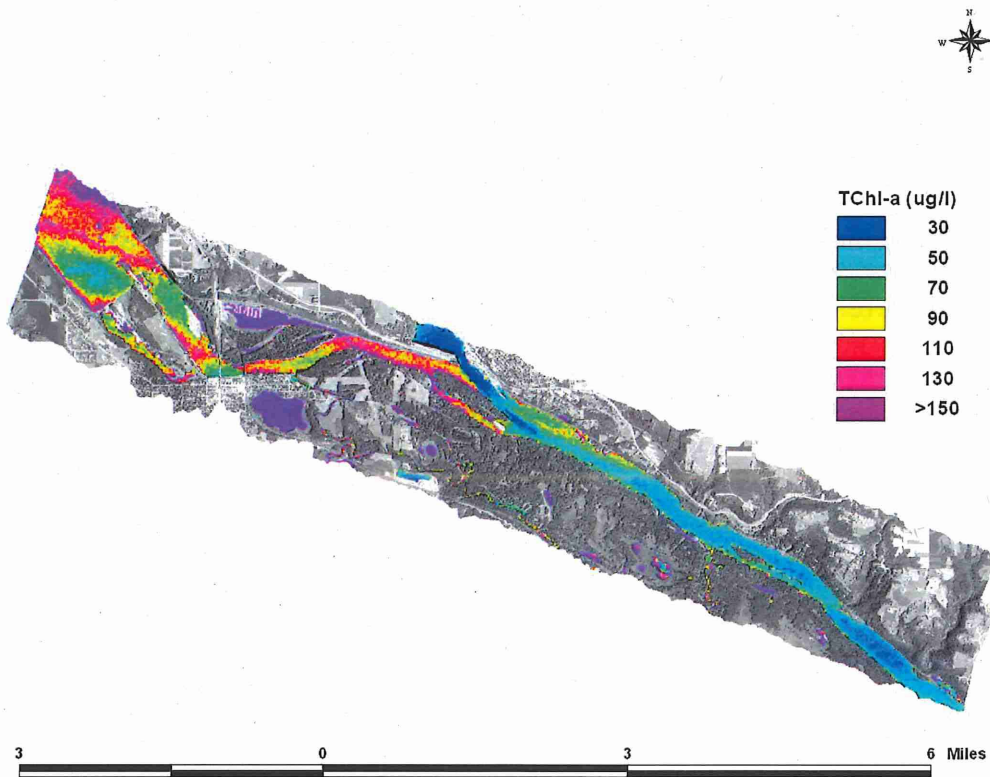
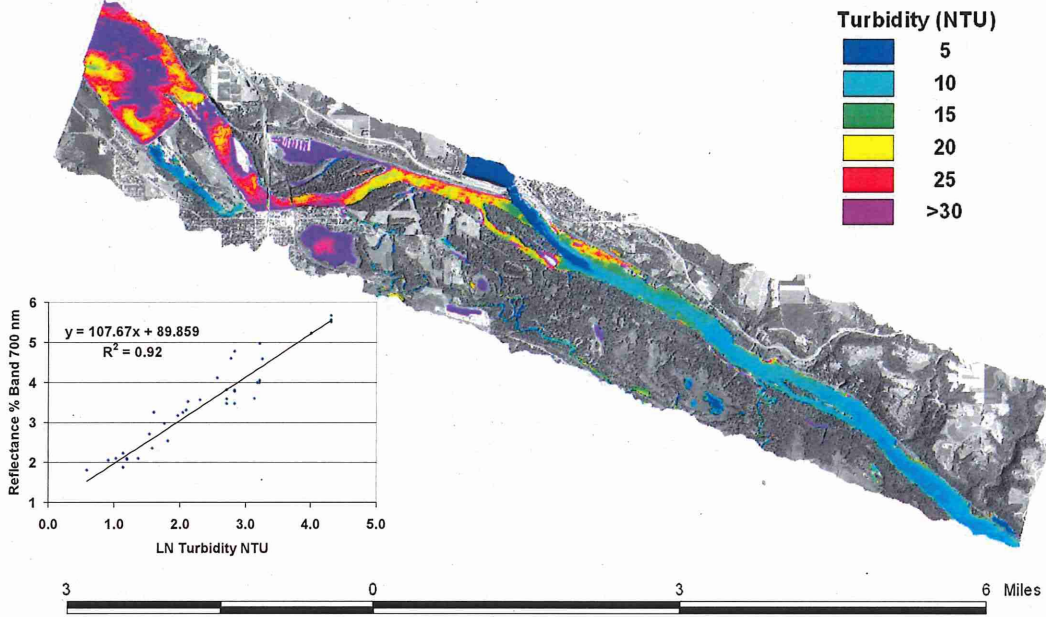


Figure 2.6. Classifications of turbidity (top) and chlorophyll a (bottom) for the St. Croix and Mississippi Rivers.

3. Summary and conclusions

The project has developed and extended the capability for using remote sensing for monitoring the condition of lakes and streams in Minnesota. Classification of lake clarity using Landsat satellite imagery has proven to be an accurate and economical method to monitor the condition of over 10,000 lakes. During the project data for 1985, 1995, and 2005 were classified and added to previous classifications for 1990 and 2000. The five classifications at approximately five-year intervals over a 20-year period provide an unprecedented assessment of lakes in terms of number of lakes, number of classifications, and geographic scale. These data will be used for further analysis of the temporal and geographic patterns and trends. Initial analysis for the 1990 and 2000 indicates relatively stable conditions statewide, but more meaningful analyses are now possible for individual lakes, as well as by lakeshed, watershed, county and ecoregion. Data for all lakes and years are available at our water.umn.edu webpage that includes a web-based mapping tool that enables searches and display of results for individual lakes. In addition, we have demonstrated the potential of MODIS imagery for monitoring not only lake clarity, but chlorophyll, of large lakes. These capabilities are now available for routine, regular monitoring by the state.

The second part of the project has been to acquire and analyze hyperspectral imagery of a representative sample of major streams to evaluate the potential for mapping key biophysical properties and indicators of water quality. Strong relationships to key indicators of water quality, including chlorophyll, suspended sediments, and transparency, were found and models of spectral reflectance to the biophysical variables were derived and used to map spatial patterns and variation for the streams. This phase of the project is being continued in a 2005 LCMR project with additional imagery acquired in 2005, however, the initial results are very promising and indicate excellent potential for monitoring and mapping key river properties. The biggest limitation is the cost of the remote sensing data and that currently we must contract for its acquisition.

The overall conclusion of the project is that lake and stream properties can be accurately monitored and mapped using contemporary remote sensing technology.

Appendix C
Minnesota Waters Final Report

LCMR REPORT – RCM/MLA PORTION

Final Outline of Project Result 3

Rivers Council of Minnesota (RCM) and the Minnesota Lakes Association (MLA) merged to form Minnesota Waters (MW) on January 1, 2006. The work program for this LCMR grant had been completed by September 2005, with the only outstanding invoices remaining on the Minnesota Lakes Association Account for 2 lake associations and a yet to be purchased piece of monitoring equipment. Therefore, the majority of reporting was done under the two separate entities, reflected below.

Final Balance:	Rivers Council of Minnesota	LCMR Budget	\$ 137,375.00
		Reimbursed	\$ 137,375.00
		Balance	\$ 0.00
	Minnesota Lakes Association	LCMR Budget	\$ 112,625.00
		Reimbursed	\$ 112,265.03
		Balance	\$ 359.97

Lakes and Rivers Monitoring Conference

The 2004 Lakes and Rivers Conference theme was: *Citizen Stewards of Minnesota's Waters*. MLA and RCM staff and volunteers developed and identified program speakers, sessions, and workshops, as well as publicity and recruitment for the conference. Using postcards and brochures, approximately 19,000 citizens were contacted about the conference. The conference was held April 29-May 1, 2004 at Ruttger's Bay Lake Lodge in Deerwood, Minnesota.

Over 325 participants attended the statewide Lakes and Rivers Conference, hosted by the Rivers Council of Minnesota and the Minnesota Lakes Association. During the conference, 35 sessions and workshops were held, ranging from water issues and monitoring training to communication and capacity building. A special focus on citizen volunteer water quality monitoring yielded a capacity crowd at each session. Participants in this track explored several citizen monitoring topics including: the data to information to action process, barriers and successes in citizen monitoring, and goal setting for high quality, useable data. The plenary session featured a discussion on the value of Citizen Stewards, conducted by local and state leaders.

Comments and evaluations from participants have been overwhelmingly positive. For many, the best part of the Conference was "the chance to ask questions and participate in sessions," "knowledge of speakers and their enthusiasm for preservation of our own environment," and "the ability to ask knowledgeable people for their advice, to learn new ideas and plans of action and hope."

Monitoring Plan and Development

RCM and MLA, with support of a sub-contractor (River Network) began developing a Citizen Volunteer Monitoring Program Planning and Implementation training workshop in the fall of 2003. This included development of the application process, development and implementation of the pilot workbook and reference manual, planning and training materials, session agendas for each day, participant homework assignments between each session, along with training techniques for the workshop presentations. Individual assistance to help answer questions and facilitate plan completion and implementation was available to each group.

Over 60 applications were received for this first training. Seven citizen groups were chosen based on the pilot plan criteria that included a recognized need for citizen involvement in water resources, commitment to data use, and a variety of lake and/or river focus and current program levels. Six groups, with 24 leaders trained, developed citizen volunteer monitoring plans, underwent a review process, and began implementation in April of 2004.

A detailed evaluation, including statistical t-tests, from the first round pilot training was completed to improve on future training sessions. Based on the first pilot training, trainers learned and adjusted various components for the second training. For example, participants in the first round requested more workshop time and commented on how helpful the individual time was to the development of their plan. The second training was adjusted to add an additional day and the focus remained on a high ratio of "group work time" during the session.

Applications for the second pilot round were released in April 2004. In late June, seven groups were selected from over 30 applications received and the second training was held in August and September 2004 at the Deep Portage Conservation Reserve near Hackensack, MN. Representatives from LCMR, PCA, RCM and MLA observed the first session and received copies of the training manual. The seven groups, with approximately 27 leaders trained submitted draft and final plans to RCM and MLA.

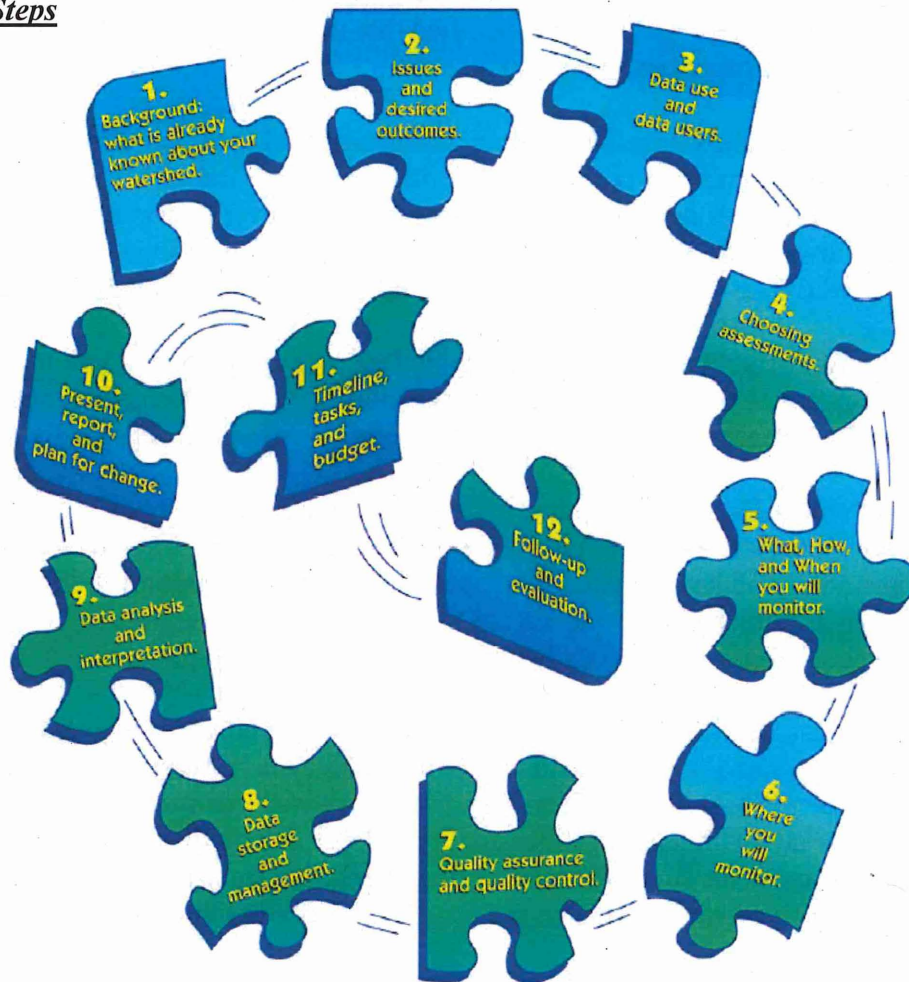
In the two pilot rounds a total of 95 applications were received representing 73 citizen monitoring groups (twenty-two groups applied to both trainings). After the 13 plans were approved, groups implemented their monitoring plans using \$3,000 implementation grants for items such as equipment and laboratory fees.

Minnesota Waters (the merged entity that previously was Minnesota Lakes Association and Rivers Council of Minnesota) continued to provide technical support to the groups who have participated in the training. Outcomes from the training include:

- 50 citizen monitoring leaders representing 14 groups trained in 2 pilot rounds,
- 13 groups completed monitoring plans,
- 153 stream sampling sites on 66 streams,
- 80 lake sampling sites on 56 lakes
- Over \$36,000 in implementation grants used by citizen groups to advance their programs

Although some citizen programs/sampling sites existed prior to training, none had gone through the detailed process that matched up goals, methods, and outcomes. Program leaders answered questions based on this model, developed by RCN, MLA, and RN:

***Monitoring Plan
Steps***



Implementation and Data Use - After Completion of Monitoring Plan Process:

Beltrami County Lakes and River Association (BCLARA): Through this plan development and implementation, they worked with twelve BCLARA member associations to provide equipment, training and financial assistance. Monitoring data used to develop an informational brochure to communicate water quality issues to its members and other county residents. They feel through this process, their County Commissioners finally beginning to recognize the importance of the lakes to the economic level. The Association is being more proactive with the county, Environmental Services and the SWCD. They say that they may not be doing anything more than basic monitoring, but through it they have become more involved in water issues. Merilee Myers became a member of the Planning & Zoning Commission and the Board of Adjustment after participating in the training.

Briggs Lake Chain Association: Shoreline restoration projects resulted from relating water quality to property values - which seems to have had a positive effect on landowners. They also now share data in monthly newsletters. Through more consistent and concentrated monitoring they can see difference in the data from lakes monitored. (The DNR doesn't collect data often or consistently enough to detect the water quality differences.) Increased lake level data will be used to augment our data interpretation. They learned that now they need to study rivers to see why there is a change in phosphorus on Big Elk.

Dam and Long Lake Watershed Plan Committee: Using data gathered by volunteers, they are gaining the attention of a number of complacent propriety owners. Better communication with property owners (PO) on water quality issues. Put something in every newsletter issue (4x/summer) about how to care for water. Helped educate PO bringing about changes in attitude. We know who to ask for help, and know enough to talk with them about it.

Dodge County Environmental Quality: Implementing the monitoring plan, a volunteer collected data on the South Branch of the Middle Fork of the Zumbro River and identified low transparency - which was previously unknown to the natural resource professionals.

Green Lake Improvement District: Their data collection on the lake and many inlets and suggested that two inlets have shown to be a major source of nutrients. They have done fecal coliform bacteria studies and have notice high counts on one site, which they are following-up to get more data and try to understand the source. At this point, the Association is using the data to determine baseline conditions and to get a better idea of the overall water quality of their lake.

Hungary Jack/Leo/West Bearskin Committee: Development of a comprehensive database for each lake resulting from Judy Hunder attendance at the Lake Data Assessment workshop (Brainerd). The database will provide information to the lakeshore residents and the Cook County Water Planner about changes in water quality. They have doubled our dues for monitoring and will escrow the funds for further monitoring. Monitoring, education and septic survey has led to two new septic systems on the lake. Data suggests that our drinking water in good shape.

Pelican Lake Association of St. Anna: The team found high counts of bacteria at several sites, at which one site a development was proposed. The citizen members took their data to their county commissioner and to the planning commission during a public hearing. They shared their data and what it could potentially mean for the lake if further development were to occur. The commission denied the request for rezoning and the development was stopped. Since then, the Association has worked with several land owners on the lake to restore native vegetation to the shoreline. Using their monitoring data results as a guide, the association has contacted several landowners to restore wetlands in the watershed. The group continues to monitor and can show noticeable drop in bacteria counts in their samples.

Pelican Lake Property Association: Joe Hampl became a manager of Thirty Lakes Watershed District (TLW) shortly after taking the monitoring plan workshop. The process increased their awareness and deepened their understanding so they could better understand issues that arise in

conversation and at government and civic meetings. They say that they now feel more comfortable standing up and talking about what we are doing and where we are going and in answering questions. Data used for education, communication, getting others involved, focusing on problem spots and building baseline data at some new sites. The Monitoring Plan Training Resulted in building a relationship with Pelican Lake Conservation Club. They feel it has come about because we are active, building credibility, attended the MPP and data assessment workshops, and putting the information of what we are doing and the data results on our website.

Norway/Games Lake Improvement Association: They feel that participating in the monitoring plan training has made them more proactive. The Board has set aside funds to continue monitoring and do extra SD readings, more ditch sampling and transparency tubes on the ditches to assess their affect on the lakes. Development of a comprehensive database for each lake as the result of attending the Lake Data Assessment workshop (Brainerd). Gave our monitor team and our board a good education and knowledge on water quality to pass on to our lake property owners.

Sauk River Watershed District: Based on citizen-monitoring activities implemented in their monitoring plan, the SRWD found "hot spots" in the Ashley Creek. They are now organizing best management practices to address land use issues in the Ashley Creek area. These "hot spots" will continue to be monitored in 2006 to determine the changes in water quality and quantity. The Big Sauk Lake Association took their responsibilities one step further by organizing a new program in 2005 targeting shoreline restorations around their lake. The lake association partnered with the SRWD in a joint effort to incorporate native vegetative buffers along Sauk Lake and assisted five lakeshore owners to install 500 square feet (per site) of native grasses, flowers and shrubs along their lake shore site. They have also used citizen data to determine the water quality of lakes and streams that they can't get to; determine where land use improvements should be targeted; determine if land use changes are indeed affecting the water quality; and educate community members on water quality.

Suomi Area Lakes Association: Through implementation of this plan, they has produced more standardized and consistent data and have a better understanding of monitoring goals and relationship with the Itasca SWCD and DNR. They have also learned that the cattle within the watershed aren't the sole reason for algal bloom. (The cattle owners had been restricting cattle from stream and reducing the number of cattle they owned.) They data suggests that interrupted flow as the result of beaver dams appears to be the major factor on the water quality leading to moving towards a move aggressive role of beaver control. They believe the plan, monitoring report and the support of SWCD will give them legitimacy to ask for lake level monitoring, and beaver trapping and dam removal.

Wadena County Soil and Water Conservation District: As a results of the monitoring plan and goal setting, the Wadena SWCD worked with RCM and the DNR to develop a Mussel Monitoring program for citizens to monitor the Shell River. The training and response was fantastic and using results from the data collection they have begun talk about trying to re-populate the creek heelsplitter and black sandshell (two special concern mussels we did not find live but should have in the Shell). They have increased the number of volunteers in the monitoring program and are adding new dimensions to the monitoring.

Some groups came to the monitoring plan training with no monitoring experience. They realized the need to monitor but didn't know what or how to monitor. By examining their issues and what or if anything was being done to address them, they developed monitoring goals specific to their lakes/streams/watersheds. All groups became more proactive, realized the need to collect consistent credible data to address those goals, develop relationships with their data users and become more active in those organizations influencing or controlling their water quality issues. Some comments on the training:

"I'm so impressed that there is an end point to the process. We left here knowing what we had to do, and had the tools to accomplish it."

"Good idea to have us bring team members – it was very important to this process."

"The workbook layout is really good. I like distinguishing between the white sheets (worksheets) and yellow sheets (background and information)."

"One to one time with facilitators was key. Thanks for planning this into the day."

Monitoring Expansion and Enhancement Projects

Skills Training 1 & 2: The Rivers Council of Minnesota helped to organize, implement, and fund the Sauk River Watershed District's 2nd Annual "Care for Your Waters" sampling workshop. In 2005 over 40 citizens from 3 major watersheds participated. They received feedback on last year's data and then completed basic training on volunteer monitoring projects they can participate in for the 2004 monitoring season. The Sauk River Watershed District will follow-up with interested volunteers to choose sites and handed-out equipment in the Sauk River watershed. RCM provided volunteer monitoring manuals, conducted training sessions to build/reinforce monitoring skills, and assisted with facilitation of the day. In 2005 over 40 citizens were trained again – including new participants and current monitors being re-certified. RCM provided an introduction to benthic macroinvertebrate monitoring and assisted with facilitation of the training.

Skills Training 3: The Minnesota Lakes Association held a lakes water quality monitoring training in the spring 2004 at the Paul Bunyan Nature Learning Center in Brainerd, Minnesota. There were 37 people in attendance, representing 22 groups. Participants received an introduction on what to include in a monitoring plan and discussed their monitoring goals. An introduction to limnology was included to put monitoring timing, site selection, data analysis, etc in perspective. Other topic covered what to include for QA/QC and a review of sampling equipment and protocols. Twenty of the groups applied for and received \$250 to implement their monitoring programs. Each group submitted a final report on their findings and expenditures. Evaluations done for this workshop were very positive, one respondent said, "I

wish all workshops had such effective and enthusiastic speakers/leaders.” “The fact that the program was designed for street level monitoring for volunteer monitoring” was greatly appreciated.

Skills Trainings 4 & 5: A stream data interpretation and analysis program has been developed as part of the monitoring enhancement and expansion. Work products include: a data training workbook/manual, cd-rom case study of the Two River Watershed, case study resources (reports, photos, etc.), brochure announcements, facilitator and participant agendas, presentation materials, basic excel assessment worksheet, and pre-post workshop evaluations. Two skills trainings, conducted in January 2005, covered the stream data interpretation materials. The first training, held in the Red River Basin, focused on a basin-wide approach to data analysis and interpretation for citizen stream data. The second training was held in central Minnesota and focused on how participants could incorporate data interpretation techniques into their citizen stream programs. Over 45 participants attended the trainings. An internal evaluation report has been prepared for this program and contains a summary of the program along with participant and facilitator evaluations. Evaluations of the training workshops were overwhelmingly positive. “A very good job in selecting, organizing, and presenting this information in a positive and interesting way,” one participant commented. “I cannot imagine this being accomplished in a better fashion.” Another participant wrote, “Hats off!!! – Take home CD and all the prep work – incredible!”

Skills Training 6: In May 2005 RCM held a macroinvertebrate sampling and identification training. Twenty-two citizen monitors and citizen program leaders representing four groups were selected to participate in the 1 ½ day training program in Clearwater, Minnesota. Workshop products included: training manual, presentation materials, and evaluations. Upon successful completion of the training and writing an action plan for their monitoring program, groups were eligible to receive macroinvertebrate sampling and identification supplies to implement their plans.

Skills Training 7: MLA targeted groups/organizations needing help to expand their monitoring programs by recruiting and training new volunteers. In April of 2005 MLA provided monitor training to 23 lake associations. Training included Secchi disk, total phosphorus and chlorophyll-*a* sample collection. Integrated samplers and lab fees were provided to twenty-one newly trained citizen monitors.

Skills Training 8: Using the training workshop developed in Skills Training 7, MLA provided on-site lake sampling training for three additional lake associations to expand their monitoring programs. These groups received integrated samplers to implement their lake sampling, but no laboratory fees.

Skills Training 9 & 10: A lake data assessment and interpretation workshop was developed. Work products include: Data training workbook, CD case study of Sybil Lake in Otter Tail County, announcements, facilitator and participant agendas, excel primer and worksheet, pre and post workshop evaluations. MLA conducted 2 trainings (June and September, 2006) on lake data assessment and interpretation. Eleven citizens representing six lake associations attended the June workshop in Detroit Lakes. Twenty-three citizens representing thirteen lake

associations, one County Collation of Lakes, one Watershed District and one agency attended the September workshop in Brainerd. As groups begin the process of data entry and assessment, MLA will be available to advise them.

Newsletter: The first edition of the Minnesota Water Watchers newsletter was developed and published in the winter 2004. Approximately 3,866 Minnesotans received the publication, which includes: specific resources to improve or expand citizen monitoring programs, education on monitoring topics, current and upcoming events, and celebration of citizen volunteers through sharing their stories. The second edition of the MN Water Watchers Newsletter was released in spring 2005. The theme was getting citizen monitors prepared for the sampling season and article topics included stream and lake sampling, and success stories of citizen monitoring programs. The newsletter was received by over 3,800 individuals and is also available on the web.

Cumulatively, 300 participants attended these 10 skills trainings (RCM and MLA conducted two additional skills trainings; only 8 trainings were identified in the Work Plan). These participants included individual citizen, natural resource professionals, local government staff, and nonprofit staff all working towards one common goal: expanding or enhancing their citizen-based water quality monitoring programs.

Products of the Rivers Council of Minnesota and Minnesota Lakes Association Monitoring program 2003-2005 (attachments will be mailed for inclusion with this report):

- 1) Design Your Monitoring Plan 2003-04 Training Manual, Supplement Resource Manual, Agendas and Evaluations *(provided to MPCA and LCMR during their visit to Deep Portage in August 2004).*
- 2) Design Your Monitoring Plan Pilot Training brochure *(enclosed)*
- 3) Evaluation of the "Design Your Monitoring Plan Pilot Program *(enclosed)*
- 4) We have Stream Data Now What?! Stream Data Interpretation Training Manual *(enclosed)*
- 5) Internal Evaluation of the We have Stream Data Now What?! Program *(enclosed)*
- 6) We have Stream Data Now What?! Brochure *(enclosed)*
- * 7) Lake Data Interpretation Training Manual, MPCA *(to be sent)*
- 8) Evaluation of 2004 Water Quality Monitoring Workshop, Brainerd *(enclosed)*
- 9) Evaluation of Lake Data Assessment Workshop, Detroit Lakes *(enclosed)*
- 10) Evaluation of Lake Data Assessment Workshop, Brainerd *(enclosed)*
- 11) Stream Benthic Macroinvertebrate Training Manual *(enclosed)*
- 12) Rivers Council of Minnesota's Monitoring Catalog *(enclosed)*
- 13) Minnesota Water Watchers Newsletter Winter 2004 *(enclosed)*

- 14) Minnesota Water Watchers Newsletter Summer 2005 (*enclosed*)
- 15) 2004 Minnesota Lakes and Rivers Registration Brochure (*enclosed*)
- 16) 2004 Minnesota Lakes and Rivers Conference Program Brochure (*enclosed*)
- 17) 2004 Minnesota Lakes and River Conference Monitoring Newsletter (*enclosed*)
- 18) Rivers Council of Minnesota Annual Report 2004 (*enclosed*)
- 19) Rivers Council of Minnesota Annual Report 2005 (*enclosed*)
- 20) 13 Group Monitoring Plans and reports (*in MPCA file*)
- 21) Beltrami County Lakes and Rivers Association brochure (*enclosed*)

Supporting Documents

- ❖ **Minnesota Waters**
 - **Monitoring Plans (13 hard copies)**
 - **Brochures (4)**
 - **Training manuals (2)**
 - **Newsletters (2)**
 - **Annual Reports (2)**
 - **Program Evaluation Reports (5)**
 - **Conference brochure and registration forms**
- ❖ **Initiative Foundation**
 - **Healthy Lakes and Rivers Partnership Manual**
 - **Lake Management Plans (2 hard copies, 20 on CD)**

2003 Project Abstract

For the Period Ending June 30, 2006

TITLE: Accelerating and Enhancing Surface Water Monitoring

PROJECT MANAGER: Daniel Helwig

ORGANIZATION: Minnesota Pollution Control Agency

ADDRESS: 520 Lafayette Rd N, St Paul, MN 55155

WEB SITE ADDRESS: <http://www.pca.state.mn.us/index.cfm>

FUND: Minnesota Environment and Natural Resources Trust Fund

LEGAL CITATION: ML 2003, Ch. 128, Art. 1, Sec. 9, Subd. 07(b)

APPROPRIATION AMOUNT: \$740,000.00

Overall Project Outcome and Results

This project was designed to enhance and accelerate surface water monitoring using a variety of methods. The condition assessment of 172 stream reaches was completed over two monitoring seasons. Monitoring was conducted in the Lower Mississippi, Cedar, Des Moines, Missouri, Red, and Rainy River Basins. This acceleration will lead to the earlier completion of the calibration of indices of biotic integrity (IBI) for all the basins in Minnesota. All data is available online. Over 10,000 lakes were analyzed using Landsat imagery for transparency over a 20 year span (at 5 year intervals). This provides a tool to extend the census of water quality data across the state and over time. Data from this project are available to the public online. MODIS imagery was used to monitor 100 large lakes for both chlorophyll and transparency. Hyperspectral and in situ data was collected at 37 sites on four river segments to develop a remote sensing tool for rivers. The Lakes and Rivers Monitoring Congress was attended by 325 participants. Fifty citizens, representing 14 groups, completed Monitoring Plan Training. Thirteen plans were developed and monitoring occurred at 153 sites on 66 streams and 80 sites on 56 lakes. With over 95 applications for the 14 openings, this pilot project showed a need for this type of training. The training materials are now available online for interested parties. Ten skills trainings, covering topics from data management to sample collection were attended by 71 groups and 300 individuals. Two editions of the Minnesota Water Watchers newsletter were developed and distributed to 3800 citizens. Healthy Lakes and Rivers Program trained 62 lake or river associations (423 individuals), with 39 Lake Management Plans developed. Volunteers in additional counties are undergoing training as a result of this successful expansion of the program.

Project Results Use and Dissemination

Data from the biological monitoring can be found online at:

<http://www.pca.state.mn.us/data/edaWater/index.cfm>. Data from remote sensing can be found at: <http://water.umn.edu/lakebrows.html>. Training materials are available from Monitoring Plan Trainings at: <http://www.riversmn.org/resources/citmon.html>. Monitoring Plans (13) and Lake Management Plans (39) have been used to initiate implementation activities.

Presentations on Satellite Remote Sensing were given at the National Conference on Enhancing the States' Lake Management Programs (2004), the Minnesota GIS/LIS Annual Conference (2005), the LCMR Southeastern MN Tour (2005), the North American Lake Management Society Symposium (2005), the Minnesota Water 2005 and Annual Water Resources Joint Conference (2005), and the MPCA Lakes, Streams, Wetlands, & Groundwater Team Meeting (Feb 2006). Presentations on the Monitoring Plan Trainings were given at the National Water Quality Monitoring Conference in May of 2006.