

Chapter 4: Inland Lakes

Lake Planning and Management

All of Wisconsin's 15,057 inland lakes are considered a significant public resource. The great variety of lake types makes management a challenge. Lakes range in depth from a few feet to 236 feet (Big Green, Green Lake County), from small ponds to 137,708 acres (Lake Winnebago, Winnebago County), and from clear soft water lakes to hard lakes prone to intensive algal growth.

Wisconsin's Lake Management Program combines monitoring and water quality assessment, research, and community financial, organizational, educational and technical assistance. The purpose is to plan, protect and restore the state's lakes and their ecosystems in partnership with other agencies and citizens. The Wisconsin Lakes Partnership is a team of WDNR and University of Wisconsin-Extension staff and citizens represented by the Wisconsin Association of Lakes, who bring technical expertise, outreach and stakeholder concerns together to focus on the state's lakes.

The 2000 305B Report highlighted lake management activities for the 1990-decade. This served a dual reporting purpose in that the close of the century also marked the projected end-point of

For more detail on the individual aspects of the Lake Management Partnership, consult the 1994 Water Quality Assessment Report to Congress or visit the Partnership website at <http://www.uwsp.edu/cnr/uwexlakes/>

the Lake Management Partnership's last strategic plan. In 2001, a new strategic plan, the *Water Way* was completed. This report primarily focuses on activities and accomplishments for 2000 and 2001 with an eye toward implementation of activities over the next 10 years.

Strategic Planning

In the spring of 2000, a group of people concerned with the future of Wisconsin lakes gathered in Rhinelander to chart a course for working together on lakes issues. Visions, goals, strategies and performance measures were compiled from a facilitated two-day exercise led by members of the Wisconsin Lakes Partnership. The draft was shared at the 2001 Wisconsin Lake Convention and posted on the Partnership's website for review and comment. The completed plan, *The Water Way*, provides a map for the Partnership's work in the first decade of the 21st century.

Lake Organization and Education Assistance

The University of Wisconsin Extension (UWEX) at Stevens Point provides lake organization and education assistance statewide. Staff at UWEX provide development, publication and distribution of printed and electronic media, providing useful information to the citizen members of Wisconsin's hundreds of lake management organizations on a hosts of issues ranging from water law to limnology. It also publishes a quarterly newsletter, *Lake Tides*, which has a distribution of approximately 23,000. *Lake Tides* and many other publications are also now offered on-line through the Wisconsin Lakes Partnership website.

In March of 2001, UWEX published a comprehensive guide *Wisconsin Water Law: A Guide to Water Rights and Regulations*. Approximately 115 consultants, attorneys and government officials and staff attended a conference in May on the topic of Wisconsin's water law. A final draft of a book on recreational use on Wisconsin's waters, *How's The Water: Recreational Use on Wisconsin Lakes* was completed in 2001. The draft will be distributed at the 2002 Wisconsin Lake Convention for comments and will be finalized shortly thereafter.

UWEX is also the location of the Partnership's youth education efforts, staffing and coordinating the Project WET and Adopt A Lake programs. Over 635 teachers and youth participated in these program's various workshops in 2001.

To better prepare the next generation of citizens for positions in lake advocacy, the Wisconsin Lake Leaders Institute was established through UWEX in 1998. In 2000 the third "crew" of 30 people completed their training and in 2001, twenty-three past graduates of the Institute attended an Advanced Seminar focusing on water law and water use conflict.

UWEX staff also makes numerous “house calls” attending and speaking at numerous lake organization meetings, lake fairs and related events. Approximately 1200 people are reached annually through conferences and community meetings conducted by UWEX staff.

Finally, the Partnership was host to the North American Lake Management Society’s 2001 International Symposium November 6 through 10 held in Madison. Attended by over 600 people from 19 countries, the Symposium focused in bridging the gaps between science and policy. It was regarded as one of the most successful NALMS events ever held.

Aquatic Plant Management

Nuisance aquatic plants can limit aesthetic and recreational enjoyment of lakes and replace beneficial native plants that provide food and cover for fish and other wildlife. Historically permits have been issued for chemical treatment only to alleviate severe problems in specific areas. Manual and mechanical harvesting has gone largely unregulated. Much of Wisconsin’s aquatic plant management, and especially preventing and managing the spread of invasives, particularly Eurasian water milfoil, have relied primarily on educational efforts.

In 2001 the Wisconsin legislature passed Act 16 which provides a comprehensive approach to lake aquatic plant management. The new law provides for watercraft inspections, information and education, research initiatives, purple loosestrife management and directs the DNR to implement a statewide program. Authority in the new law:

- Prohibits launching of watercraft with aquatic plants & zebra mussels;
- Regulates all the methods of aquatic plants management;
- Requires posting of public boat access sites;
- Designates invasive plants as EWM, curly leaf pond weed and purple loosestrife. Additional plants can be added by rule.

Rules to implement the new law are now being developed for enacting late this spring. A permit will be required for all methods of control including manual and mechanical removal as well as the introduction of nonnative aquatic plants. Plan approval for enacting most control methods will be required by rule.

One key component of the aquatic plant management program is the identification of sensitive areas for protection that provide critical or unique fish and wildlife habitat, scenic beauty and other factors. The WDNR encourages a sensitive area survey as part of lake planning activities and recently compiled standardized methods for conducting these activities statewide.

Clean Lakes Program

In 1998, U.S. EPA amended its guidance for administering Nonpoint Source Pollution Abatement Program (section 319) to make all section 314 Clean Lake Program Activities eligible under s. 319. This allows Wisconsin to once again fund Clean Lake Program activities that were suspended when funding for s. 314 was eliminated in 1995. Wisconsin has completed all program funded activities previously funded under the s. 314 Clean Lakes Program. WDNR amended its work plan under section 319 to make Clean Lake Program activities eligible and reestablished the state’s Lake Water Quality Assessment Program, including lake monitoring and reporting. Currently, section 319 funding is used to support Lake Program activities including:

Self-help Citizen Monitoring – All aspects of this program including administration, data management, reporting and equipment purchase.

Lake Partnership Activities – Providing technical and informational assistance to lake organizations and management units, processing and administering the lake grant program, managing lake data and support for statewide meetings, conferences and training sessions.

Lake Planning and Evaluation – Support to select regional projects including exotic species prevention and monitoring, developing aquatic plant and sensitive area surveys, and collecting and summarizing water quality data and management actions on specific lakes.

Lake Protection and Restoration – Select projects that will protect or improve lake water quality and lake ecosystems. In 2002, \$100,000 from s. 319 will be used to assist in the restoration of Devil’s Lake, Sauk County. Installation and operation of a bottom water withdrawal system will “mine” accumulated phosphorus from lake sediments over a period of approximately 15 years.

This will reduce lake nutrient concentrations, alleviating fall algae blooms, incidences of swimmer's itch, and the bioavailability of mercury.

Lake Planning and Protection

WDNR's Lake Planning and Protection Grants have a major and diverse impact on the management of the state's lakes. These grants, which are 75% state cost-shared, are at the core of the partnership between state and local entities that are striving to protect and restore lakes and their ecosystems. Currently, \$2.6 million is allocated annually to support a balance of locally-initiated projects ranging from data collection and development of lake management plans to land acquisition, local ordinance development, and management plan implementation (refer to Table 17).

Table 17. Planning and Protection Grant Activity 2000 – 2001

Project Type	No. Lakes	Grants Awarded	\$ Awarded
Total - All Grants	>174	211	5,390,000
Lake Planning	>116	159	1,290,000
Plans & Assessments	116	147	1,193,000
Regional Land Use	Multiple	12	97,000
Lake Protection	>58	52	4,100,000
Land Acquisition	12	12	1,346,500
Watershed BMPs	5	5	797,500
Diagnostic/Feasibility	30	4	306,000
Wetland Restoration	0	0	0
Classify/Ordinance	Multiple	20	830,000
Lake Restoration	11	11	820,000

Lake Planning Grants

Over one-hundred lakes and lake-chains were the subject of a study at least partially funded by the Wisconsin's Lake Planning Grant Program during this two-year period. These efforts include conducting water quality assessments and watershed inventories, developing nutrient budgets, conducting education programs and writing management plans (see Table 17). These plans often become the basis for protection grant applications or other sources of funding and assistance. For local units of government where there are an abundance of lakes, regional land use plans that focus on water resource protection are also funded.

In the last grant cycle of 2001, small-scale projects, capped at \$3,000 per grant for trend monitoring, limited investigations, lake organization development and education efforts were offered for the first time. While the focus of the planning grant program traditionally emphasized comprehensive lake management planning, small-scale grants were developed to allow organizations to either ease into the planning process or conduct activities consistent with implementing protection strategies like trend monitoring and education. The changes were successful in broadening the availability of the funding to lakes that had not been previously engaged in the planning program. More diversity is on the horizon for this particular program as well.

Changes to the enabling legislation in 2001 allow schools districts to become sponsors of lake education efforts, providing a tie to implementing Adopt a Lake and Project WET activities.

Long Lake Watershed Assessment

Long Lake is a 1,052 acre, 101 foot deep drainage lake tucked into the forested moraine of northern Chippewa County. Historically oligotrophic, DNR's long term monitoring data indicated rising phosphorus levels and decreasing clarity. The lake protection district had done little formal planning and became concerned for the future of their pristine lake. With a limited budget and a modest state lake planning grant of only \$2,475, they were able to contract with Applied Data Consultants, Eau Claire, to conduct a watershed assessment for setting nutrient management goals. Using GIS technology, publicly available digital land information, and Wisconsin's Lake

Modeling Suite (WiLMS) the consultants provided the District with maps of the lake's subwatersheds ranked in terms of high, medium or low potential phosphorus loading. This first level screening will allow the District to efficiently focus its future planning and management efforts on the most critical areas within the lakes' seven square mile watershed. This project also demonstrates that technology can deliver good quality products at low costs.

Lake Protection Grants

Lake Protection Grants provide up to \$200,000 per grant for implementing projects that protect lakes and their ecosystems. In 2000-01, implementation projects took place on 32 lakes. These grants were used for land acquisition, watershed best management practices and in-lake restoration activities. In the last category, five lakes covering approximately 3,00 acres received grants for alum treatments or aeration systems to inactivate internal nutrient cycling providing dramatic improvements in lake water quality. Twenty of the projects were directed at regional protection efforts, encompassing large numbers of lakes, for classification and management efforts such as local ordinance development and diagnostic and feasibility studies.

Recent changes to the enabling legislation specifically allow for the development of a shoreland and littoral zone restoration grant sub-category to keep pace with the demand for these types of projects. Administrative rules are now being developed to implement this clarification of statute.

Silver Lake Restoration

Silver Lake is a lightly developed 69-acre lake just outside the city limits of Manitowoc. During construction of State Hwy 151 in the 1930's, Silver Creek was routed directly into Silver Lake expanding the watershed area to lake area ratio from about 6:1 to 175:1. Resulting poor water quality conditions placed extreme limitations on the lake's fish population and recreational uses eventually landing the lake on the State's 303(d) list of impaired waters. Following a 10-year effort to control nonpoint sources in the watershed, it became apparent that additional actions were necessary to achieve any significant water quality or habitat improvements. In 2001 a major construction project was completed to divert the creek out of the lake via the construction of an earthen berm and water control structure. The \$454,000 project was supported by a combination of state grants and local funds with the County being the project lead. In the coming year, fish eradication and an alum treatment should restore the lake to a useable condition. A TMDL is currently being developed for the lake.

Lake Classification & Ordinance Development Grants

Lake classification grants provide up to \$50,000 to counties to "classify lakes by use and implement protection activities for the lakes based on their classification." Other units of local government and lake associations can receive up to \$50,000 to develop ordinances and conduct the land use planning activities that will protect lake resources. To date, more than half of the state's 72 counties and many townships have undertaken lake classification or ordinance development projects to facilitate improvements in shoreland zoning and land use management (Figure 22).

Other Lake Program Activities

Lake Manager Training

The Lake Partnership Team has begun development of a lake manager training series for staff and partners involved in lake management. The first series of sessions on lake planning, goal setting and lake modeling was recently conducted. The focus was on the use of the redesigned Wisconsin Lake Modeling Suite (WiLMS 3.0) a lake water quality-planning tool.

Lakes Assessment

As the table below shows, over 792,301 lake acres are listed as impaired for one or more designated uses due to the presence of a general fish consumption advisory for mercury for all Wisconsin surface waters. Specifically, 767,533.4 lake acres were assessed for aquatic life uses and 361,598 were found to be fully meeting this designated use, while 270,055 are not meeting this use (see Chapter 2 for the assessment methodology used). The total number of lake acres assessed in

2002 is less than in previous years due to Wisconsin “cleaning” and quality control checking its assessment database; this process involved updating information and removing duplicates.

Status of Wisconsin Lakes

Table 18. Fully Supporting, Threatened and Impaired Lakes (Data from 305b waterbody database)

Degree of Use Support	Assessment Basis		Total Assessed
	Evaluated	Monitored	
Size Fully ALL assessed uses	0	0	0
Size Fully ALL assessed uses but Threatened for at Least One	0	0	0
Size Impaired for one or more uses	33518.80	758,782.60	792,301.40
Size Not Attainable for any use and not included in items above	0	0	0
Total Assessed	33518.80	758782.60	792301.40**

** Based on the presence of a general fish consumption advisory for mercury for all Wisconsin surface waters.

Table 19. Individual Use Support, Lakes - National & State (Data from 305b waterbody database)

Use	Size Assessed	Fully	Threatened	Partial	Not
Aquatic Life Use Support	767533.4	361598.8	42346	93532.8	270055.8
Fish Consumption	786349.4	0	0	0	786349.4
Primary Contact	55495	539	0	54251	705
Secondary Contact	439991	100425	19688.8	189873.6	130003.6

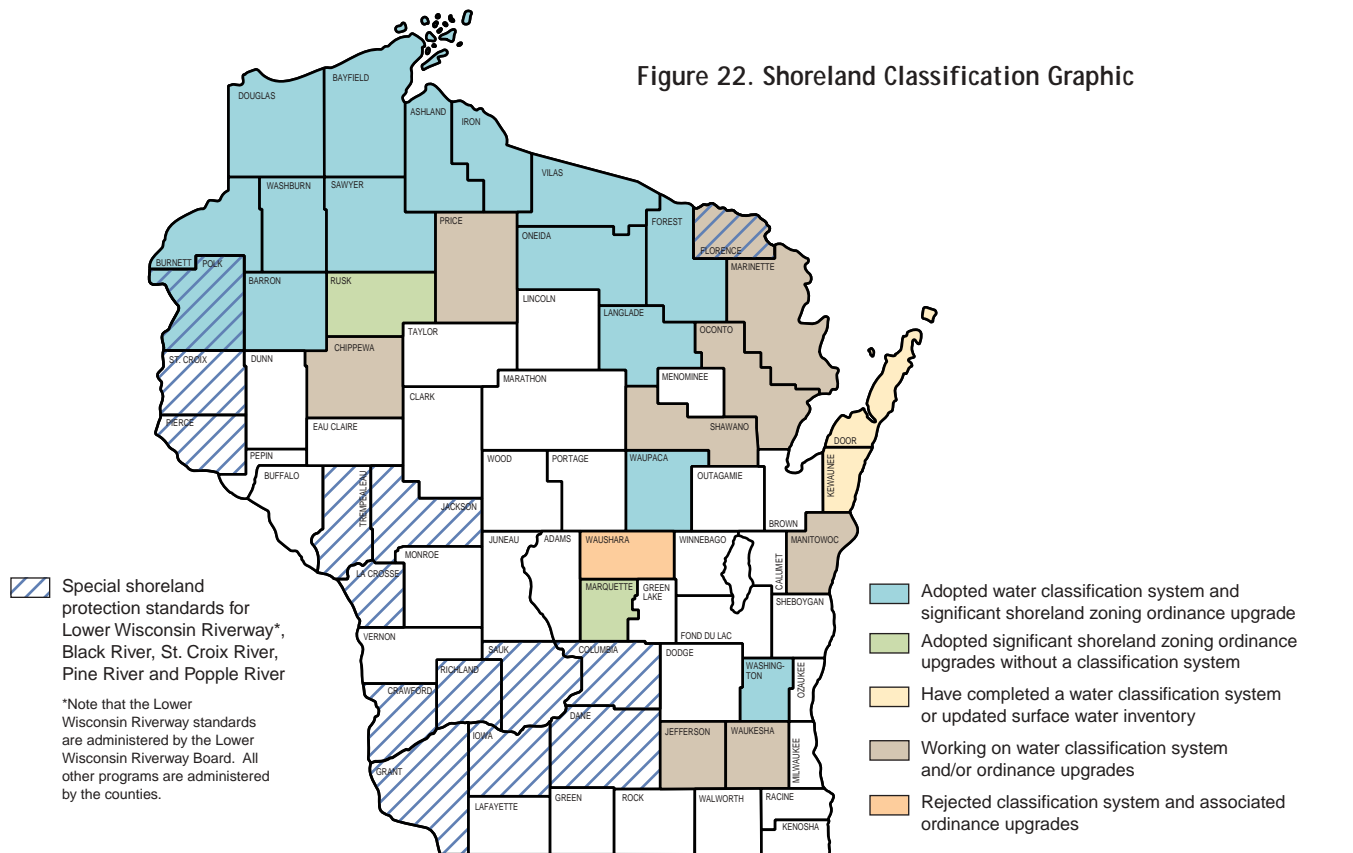


Table 20. Total Sizes of Lakes (Acres) Impaired by Various Cause/Stressor Categories

Cause/Stressor	Size of waters by Contribution to Impairment
Pesticides	1053
Metals	19269
Mercury	786,349.40**
Chlorine	87
Nutrients	103166
Other	3910
Siltation (includes Sedimentation)	62194.7
Organic Enrichment/DO	31951.6
Flow Alterations	1153
Other Habitat Alterations	46096
Pathogen Indicators	455
Noxious aquatic plants (macrophytes)	51171
Total toxics	7564
Turbidity	52033
Exotic species	107551
Excessive algal growth	41732

** All Wisconsin surface waters are listed under a general fish consumption advisory for mercury.

Table 21. Total Sizes of Lakes (Acres) Impaired by Various Source Categories

Source Category	Size of waters
Municipal Point Sources	383
Minor Municipal P.S.	353
Combined Sewer Overflows (collection system failure)	2965
Domestic Wastewater Lagoon	43
Agriculture	50705
Crop-related sources	48089
Grazing-related sources	12225
Pasture grazing, upland	10319
Pasture grazing, riparian	1779
Range grazing, riparian	127
Intensive Animal Feeding Operations	10446
Silviculture	
Construction	27782
Highway/Road/Bridge	24
Land Development	21991
Urban Runoff/Storm Sewers	23685
Erosion & Sedimentation	26
Land Disposal	8627
Onsite Wastewater Systems	8457
Septage Disposal	170
Hydromodification	39884
Dredging	158
Dam Construction	9882
Upstream Impoundment	253
Flow Regulation/ Modification	6576
Habitat Modification (non-Hydro modification related)	39108
Bank or Shoreline Modification	11513
Internal Nutrient Cycling	6633
Recreation and Tourism Activities	732
Atmospheric Deposition	786,349.40**

** All Wisconsin surface waters are listed under a general fish consumption advisory for mercury.

Trophic Status of Wisconsin Lakes

Summarizing the trophic status for all lakes for which data were available is another way to characterize the condition of Wisconsin's lakes. Data collected on lakes by DNR staff, the Self Help Citizen Monitoring Program and through projects funded by lake grants from 1997 through 2001 was compiled by WDNR staff. A trophic state index (TSI) was estimated for 990 lakes based on Secchi disk (clarity)0. This data represents 45% of Wisconsin's total inland lake surface acreage. It is a biased sample in that it represents only the lakes that have been actively sampled. Approximately half of the waters listed in Table 22 exhibit what is considered to be excellent to good water quality (oligotrophic and mesotrophic conditions).

Table 22. Trophic State of Lakes (1997 -2001)

Trophic Condition	No.Lakes	Lake Acres
Oligotrophic	512	164164
Mesotrophic	139	47968
Eutrophic	299	190971
Hypereutrophic	40	55442
Total Assessed	990	458546

Table 23: Trends in Significant Public Lakes

	No.Lakes	Lake Acres
Assessed for Trends	708	453,459
Improving	78	36,613
Stable	258	293,324
Degrading	51	15,112
Trend Unknown	321	10,8410

Data Sources

Assessment of lakes for the 305(b) report is an integral component of Wisconsin's overall Watershed Management Program. Data used in assessments are derived from multiple sources, including the self-help monitoring program, baseline monitoring, long-term trend monitoring, and special studies. Assessments are conducted by the Bureau of Watershed Management based on lakes assessment criteria described in Chapter 2, Water Quality Assessment Criteria – Lakes.

Self-help Citizen Lake Monitoring

Wisconsin's Lake Partnership nurtures public involvement. High quality monitoring data supports sound management. WDNR relies on the public to gather much of the data. There were over 700 citizen volunteers participating in the program at the end of 2001. Interest in volunteer lake monitoring continues to increase, with over 122 new volunteers starting in 2000, and 194 new volunteers in 2001.

Table 24. Volunteer Monitors in Wisconsin, 2001

Parameter	# Volunteers (2001)
Secchi Disc Depth	709
Chlorophyll a and Total Phosphorus	354
Temperature and Dissolved Oxygen	165
Eurasian Watermilfoil	75
Purple Loosestrife	54
Aquatic Plants	44
Zebra Mussels	24

Begun in 1986, by the mid '90's Volunteer Lake Monitoring had reached a point where the number of volunteers and interest in lake monitoring exceeded WDNR's financial and data management capabilities. Beginning in 1999, this challenge was addressed through the expansion of the State Lake Planning Grant and significant improvements to the Self-Help data management system.

Offering a small-scale, trend monitoring grants package in 5-year renewable increments; grant funding has facilitated growth in the chemistry-monitoring program. Approximately 30 additional lakes can now be brought into the program per year under these grants.

In 2000, the Self-Help database was redesigned to enable staff to better track equipment, volunteer information, and to promote more efficient data management. The redesigned Self-Help Lake Data database made its debut on the web in 2001. The database is live, searchable, and contains over 15 years of data on many lakes. The new website also features a data entry form, which, starting in spring 2002, will allow volunteers to submit their data through the Internet as an alternative option to the existing touch-tone phone system or mail-in post cards.

Changes in data management have enabled Annual Reports and awards to be completed on time. Over 1,600 annual reports were mailed in 2001, and over 290 awards were distributed in 2001 to volunteers who had completed 1, 5, 10 or 15 years of monitoring, or had taken 100 or 500 secchi readings. During the 2001 season, Self-Help awarded 30 fifteen-year awards. Three of these recipients have taken over 750 Secchi readings!

Numerous other improvements have recently been made to better use Self-Help resources. New equipment has been introduced, including the Integrated Sampler, a less costly sampler made of PVC pipe, used to sample a 6-foot column of water for chlorophyll and total phosphorus. The cost savings allowed WDNR to purchase new cable-temperature probes for the volunteers, improving the accuracy of temperature profiles as well as decreasing the time a volunteer was spending on temperature profile readings.

To accommodate the new equipment, the Self-Help Lake Monitoring procedure manuals have been completely updated. These new manuals contain video clips demonstrating many procedures, and will be available to volunteers on CD-ROM, in 2002 and will soon be added to the Self-Help website.

Other changes include the folding of the content of the Self-Help newsletter, *Lake Monitoring News*, into four pages of the Lake Tides Newsletter, put out by the UWEX. This change will save resources and make the content available to many more readers. The Self-Help display board has also been updated and has been used at the 2001 NALMS Symposium, and will be used in 2002 at the Wisconsin Lake Convention and local Lake Fairs.

Also significant is Self-Help volunteers' participation in a collaborative effort with University of Wisconsin Environmental Remote Sensing Center. In 2000 and 2001, volunteers monitored their lakes on specific dates when satellites were overhead. Self Help staff then sent the data to the UW Remote Sensing Center to be used to calibrate computer programs that allow satellite imagery to be used to predict Secchi Disc Depth and other water quality parameters on lakes.

Using Satellite Imagery to Characterize Lake Water Quality

DNR has recently formed a partnership with the University of Wisconsin's Environmental Remote Sensing Center (ERSC). A primary goal of this collaboration is to investigate the use of satellite imagery in characterizing lake water quality. Figure 23 illustrates graphic layouts of this effort. The UW ERSC personnel provide the expertise in accessing satellite images and processing spectral characteristics of satellite images, while the WDNR, through its various water quality monitoring programs, provides the actual ground-truthed measurements of various parameters contributing to lake water quality.

In 2000 and 2001, hundreds of Self-Help lake monitoring volunteers coordinated their sampling efforts with the dates of Landsat (satellite) overpass. This effort successfully resulted in the development of a relationship between field measured lake water clarity and that predicted by analysis of the satellite images (Figure 24). ERSC recently submitted a proposal to NASA for further development of an image processing protocol for lake transparency monitoring via Landsat data. The goals of our future partnership include:

- Continuing to compile a current statewide database of Landsat imagery.
- Continuing to collect current water quality reference data in order to "calibrate" the above satellite data.
- Completing a statewide Landsat-based assessment of current lake transparency conditions using the above databases.
- Completing a historical statewide lake transparency assessment.
- Operationalizing the Landsat-based statewide monitoring system; this includes facilitation of the actual adoption and day-to-day use of the methods developed and demonstrated during this project by WDNR lake managers.

Figure 23. Satellite Image Graphic

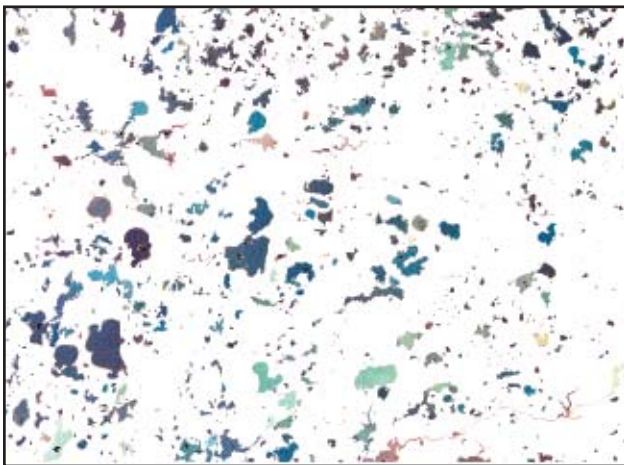
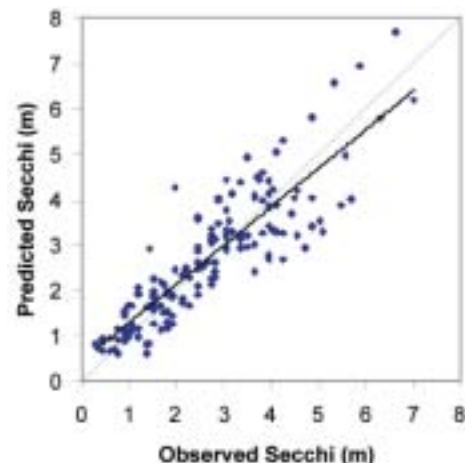


Figure 24. Comparison of field measured vs. remote sensing secchi readings



Long-term Trend Lakes Analysis (LTT)

The WDNR began a Long Term Trends Program in 1986, collecting nutrient, chemical, watershed and plant data on 50 lakes statewide to provide information for assessing, comparing and anticipating changes in lake quality. This program continues today, with some modifications to the protocols used.

In the 2000 305B Report, results of a comparison of trophic state indicators from 1986 to 1996 were presented. Wisconsin's Lakes Program is using these data to ask additional management questions. For example, are the LTT lakes representative of Wisconsin lakes overall? Are we sampling enough lakes to get a clear picture of what is happening in the state? Currently, the program is classifying the LTT lakes into six hydrologic and depth classes within each region in

Wisconsin and comparing them with a larger set of lakes to evaluate the proportionality of the numbers in the different classes. The representative value of the LTT lakes with regards to hydrologic and depth class will provide valuable data from understanding statewide trends.

Overall, trends lakes should be representative of their class in their region. Consistency within classes will be evaluated by comparing a number of variables such as Secchi depth, chlorophyll and total phosphorus levels. Following these analyses, changes may be made to the composition of the LTT lakes.

Monitoring Research

A much more complicated question is whether sampling frequency is sufficient in the program. How important are spring, summer and fall sampling results? This will vary with the question being asked. Although there have not been any trends revealed over the first eleven years of LTT sampling, managers still rely on LTT lakes to offer benchmarks against which to judge potential future change. Choosing to characterize lakes using mid-summer values would obviously make spring and fall sampling less useful. Many variables such as Secchi disk depth, chlorophyll, and nitrogen (as ammonia or nitrate) display predictable seasonal patterns of highs and low within a lake. Lake sampling during spring and autumn turnover will usually provide different results than mid-summer sampling for many of these variables. A subsampling design will be implemented to evaluate if conclusions are similar with fewer sampling dates or fewer sampling variables.

Sampler Comparison Study. Historically, a Van Dorn grab sampler has been the standard tool for collecting lake surface samples. However, over time new equipment has been introduced, including the Integrated Sampler, a less costly sampler made of PVC pipe, used to sample a 6 foot or greater column of water for chlorophyll and total phosphorus. While the integrated sampler provides cost savings, is easier to use and provides more accurate data, questions arose over data comparability — especially for trend monitoring on lakes where grab samples had been used for years.

WDNR research staff conducted a comparison study and found that the results from the Integrated Sampler for water column chlorophyll_a and total phosphorus were not statistically different from the results for the 3-foot grab sample. There was no bias of higher or lower CHL or TP when using Integrated Samplers versus Van Dorns. With this information, WDNR can proceed with using a mix of sampling gear without concerns about disrupting data integrity.

Shoreland Runoff Study

In recent years there has been a growing movement to promote protection and reestablishment of natural shorelines along residential and publicly-owned lakeshore lots. Local resistance to this practice has included the argument that water quality benefits of natural shorelines are not well documented in Wisconsin. To address this concern, the Lakes Management Partnership commissioned research to compare the volume and quality of runoff and groundwater from turf versus forested shorelands on several sites in Northern Wisconsin.

The research found that while concentrations of nutrients were not significantly different comparing lawns to forests, yields were higher for lawns by around 8:1 despite a high degree of site variation. The coefficients were generally lower but consistent with the published literature. This difference is attributed to specific exclusion of impervious surfaces in this study, which measured the vegetative lawn zone only. A second study phase will investigate near-shore hydrology impacts like impervious surface contributions. This data will also be used to update and improve the accuracy of WiLMS.