WATER RESOURCES MONITORING STRATEGY FOR WISCONSIN

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WISCONSIN DEPARTMENT OF NATURAL RESOURCES

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TABLE OF CONTENTS

TABLE OF CONTENTS **1**

INTRODUCTION **3**

MONITORING STRATEGY EXECUTIVE SUMMARY **4**

TIER 1: STATEWIDE BASELINE MONITORING **8**

LAKES 9
Self-Help Lake Monitoring *13*
RIVERS 17
Biotic Integrity Monitoring *17*
Long Term Trends Ambient Water Quality (LTT/AWQ) Network *23*
Flow Gaging *26*
STREAMS 29
Water Action Volunteer Educational Program *34*
WETLANDS 37
GREAT LAKES 40
Lake Michigan Major Tributary Phosphorus Loading *40*
Fisheries Assessments *42*
Pathogen monitoring on Great Lakes Beaches *44*
MISSISSIPPI RIVER 49
CROSS-RESOURCE MONITORING 55
Surface Water Quality *55*
Contaminants in Fish Tissue *60*
Pathogen Monitoring on Inland Beaches *66*
GROUNDWATER 69

TIER 2: TARGETED EVALUATION MONITORING **76**

TOTAL MAXIMUM DAILY LOADS (TMDL) 77
303(d) Impaired Waters List Development *77*
Source Identification & Load Assessment *79*
STREAM CLASSIFICATION USE ATTAINABILITY ANALYSIS 82
SPORT FISHERIES ASSESSMENT 85
Warmwater/Coldwater Fisheries Assessment *85*
Treaty Assessment *87*
CONTAMINATED SEDIMENTS 89
ENFORCEMENT, SPILLS & KILLS MONITORING SUPPORT 91
SPECIAL PROJECTS & RESEARCH 93

TIER 3 MANAGEMENT EFFECTIVENESS & COMPLIANCE MONITORING **96**

NON-POINT SOURCE PERFORMANCE STANDARDS & PROHIBITIONS 97
POINT SOURCE EFFLUENT & RECEIVING WATER MONITORING 103
Point Source Compliance – Chemical Levels in Effluents *103*
Whole Effluent Toxicity (WET) Testing – Biological Effects *105*
Toxicity Testing of Receiving Waters – Biological Effects *110*
PUBLIC DRINKING WATER WELL MONITORING 114

NON-DNR MONITORING PROGRAMS **116**

MONITORING PROGRAM LOGISTICS **119**

QUALITY ASSURANCE 119
DATA MANAGEMENT 120
REPORTING 124
GENERAL SUPPORT AND INFRASTRUCTURE PLANNING 125

IMPLEMENTATION **126**

TEN-YEAR TIMELINE 126
RESPONSIBILITY FOR PROGRAM IMPLEMENTATION & EVALUATION 130

APPENDIX A. CITIZEN MONITORING PROPOSAL **132**

APPENDIX B. GLOSSARY **140**

INTRODUCTION

The Water Division of the Wisconsin Department of Natural Resources (WDNR) gathers environmental information to assess aquatic environmental health, evaluate environmental problems and to determine success of management actions that are intended to protect our aquatic resources. The WDNR's Water Resources Monitoring Strategy (*Strategy*) directs our monitoring efforts in a manner that efficiently addresses the wide variety of management information needs, while providing adequate depth of knowledge to support management decisions. With this *Strategy*, the WDNR is striving to meet the goal of comprehensive coverage of all of the State's waters to the best of its ability, while maintaining the efficiency necessitated by current resource availability.

This *Strategy* employs a staged approach to information gathering, with an initial economical set of standardized sampling protocols collected statewide to insure broad spatial coverage of all our aquatic resources, and designed to identify waters with environmental problems. Where environmental problems are found, more intensive sampling then occurs to verify the cause and extent of the problem. This careful investment in monitoring effort insures that the status of our aquatic resources can be determined, without depleting the capacity to conduct in-depth analysis and problem solving where needed. Follow-up studies also are conducted on targeted waters to determine the success of management actions.

In many cases, screening-level sampling with common sets of physical, chemical and biological information will satisfy information needs for many different aspects of management. This *Strategy* establishes a Baseline Monitoring Program that implements the initial level of monitoring of all the state's major waterbodies. Consistent application of standardized methods, applied repeatedly over time, provides a context for comparing data from individual waterbodies, including the capability to compare waterbodies with similar potential to one another, and to examine ecosystem health trends over time.

Some information needs are so unique that specialized monitoring approaches must be applied. These sampling designs may require targeted sampling of specific waterbodies where environmental concerns are apparent, or may sample unique parameters that evaluate specific problems. These sampling efforts are designed and supported by management experts specific to the task, allowing customization to their information needs.

Collection of ambient water quality data such as dissolved oxygen, pH, temperature, hardness, heavy metals, and pesticides is often very important in understanding the assimilative capacity that is appropriate for a particular receiving water. These data will be collected at both long-term trend sites and in conjunction with Baseline sites. With this information in hand, staff can calculate water quality-based effluent limitations to include in Wisconsin Pollutant Discharge Elimination System (WPDES) permits for the purposes of ensuring that water quality standards are achieved. Further, there are situations where these data may be evaluated over time to document any trends or rapid changes in ambient conditions that may ultimately trigger changes in how the Department evaluates and attempts to resolve water quality problems.

The *Strategy* is meant to be dynamic, with continuing investment in research to better understand our aquatic resources, and these improved insights will be incorporated into our sampling design. The *Strategy* also requires regular review of all monitoring efforts, evaluating success of the design in satisfying management information needs, and seeking efficiencies where possible to integrate sampling effort for multiple purposes.

The following description of our monitoring program reflects the large investment Wisconsin makes in environmental monitoring. Our monitoring strategy themes are built into this wide variety of sampling efforts to insure the most efficient use of monitoring resources and that our priority information needs are met.

MONITORING STRATEGY EXECUTIVE SUMMARY

The WDNR Water Division is comprised of three Bureaus: Fisheries Management & Habitat Protection, Watershed Management, and Drinking Water and Groundwater. The Water Division Monitoring Strategy (hereafter referred to as the *Strategy*) covers all monitoring done under these three programs and identifies efficiencies that can be gained by working together. It also clarifies which monitoring efforts are used to meet Clean Water Act, Fisheries, and Public Trust Doctrine Objectives, and prioritizes where future efforts will be focused given varying funding levels. With this *Strategy*, the WDNR is striving to meet the goal of comprehensive coverage of all of the State's waters to the best of its ability, while maintaining the efficiency necessitated by current resource availability. The *Strategy* will be a fluid, working document and is meant to evolve along with WDNR's monitoring programs. Under continual evaluation and review, the *Strategy* will both provide direction and reflect the changes inherent in managing Wisconsin's water resources.

Tiered Monitoring Approach

Historically, the Bureau of Fisheries Management & Habitat Protection and the Bureau of Watershed Management have led their own monitoring programs that have operated, for the most part, independently of one another. When the WDNR reorganized in 1996, an effort was made to better integrate sampling efforts between these two bureaus. With the creation of this *Strategy*, the Water Division has revisited areas where gaps, inefficiencies, or unmet needs remain, and identified a number of areas where monitoring efficiencies can be improved while increasing usefulness of the data to both bureaus.

- The administrative Water Division Monitoring Team will set clear expectations and timelines for each Subteam. Site selection for surface water monitoring will be done through a designated process, whereby Subteams will determine specific locations and sampling schedules for the upcoming year. Subteams will meet regularly throughout the year to assess whether sampling designs are being followed and goals are being met.
- Additional ambient water quality data will be collected at each site (or a subset of sites) where biological data are being collected, to fill data gaps identified by program managers.
- Groundwater monitoring will be augmented through addition of fixed stations for groundwater quality monitoring and data management processes will be enhanced.
- A portion of current volunteer monitoring effort will be refocused to provide usable data for certain WDNR monitoring programs. Long-term, committed volunteers will be trained in DNR methods and quality control procedures, and will collect data specifically for WDNR management uses. A Citizen Monitoring Subteam will be created to guide development of this program (see proposal in Appendix A).

The following primary monitoring categories have been established:
Tier 1: Statewide Baseline Monitoring
Tier 2: Targeted Evaluation Monitoring
Tier 3: Management Effectiveness & Compliance Monitoring

It is important to note that the monitoring Tiers presented below are not meant to be hierarchical. Each type of monitoring is important, and must be allocated enough funding to ensure sufficient data collection. Further, the techniques used in each Tier are not exclusive. Monitoring methods used in individual programs may apply to other Tiers as well. For instance, sampling methods used in Tier 1 could also be applied at targeted sites in Tiers 2 or 3. Likewise, if a unique sampling design is created for a specific Tier 2 site, the same design could form the basis of subsequent Tier 3 monitoring at that same site to produce comparable before and after data.

Tier 1 – Statewide Baseline Monitoring: *Trend establishment and problem identification*

Tier 1 of this *Strategy* collects baseline physical, chemical, and biological information necessary to satisfy Water Division information needs at a broad spatial scale. This level of monitoring determines water quality status and trends in each waterbody type based on ecologically based indicators, and identifies potential problem areas. For resources that are too numerous to individually evaluate, such as streams, a dispersed sampling effort will be implemented to allow information from sampled waters to be used, through inference, to provide technically rigorous and credible information on all of the state's waters. Where environmental problems are discovered through Tier 1 monitoring or other credible sources of information, these problem areas are identified and prioritized for further study under Tier 2. Broad-scale effectiveness of management actions is determined by comparing groups of waterbodies before and after management actions are implemented to waterbodies of the same type where no management actions are taken.

Tier 2 – Targeted Evaluation Monitoring: *Site-specific monitoring of targeted areas*

Waterbodies identified under Tier 1 as falling below designated minimum levels for the core indicators are prioritized and monitored more intensively under Tier 2. Under this tier, confirmation of the problem is made, along with documentation of the cause(s). Thus, it is a more comprehensive evaluation of individual waterbodies, often requiring cross-program collaboration. The outcome of monitoring under Tier 2 is often the development of comprehensive management plans (e.g. Total Maximum Daily Loads (TMDLs), etc.) for specific waterbodies. It also provides the pre-data for determining responses to management under Tier 3. Monitoring in response to episodic events (e.g., fish kills), where the cause and extent of the problem must be determined, also falls under this tier, as do short-term, one-time studies, termed Special Projects.

Tier 3 – Management Effectiveness and Compliance Monitoring: *Determining effectiveness of management measures & permit conditions*

Tier 3 monitoring provides follow-up analysis of management plans that have been implemented for problem waterbodies, and evaluates permit compliance and the effectiveness of permit conditions. Monitoring under this tier evaluates the responses of core indicators from Tier 1 and 2 to management actions. Effectiveness of waterbody-specific management actions is determined using core indicators from the more intensive sampling designs under Tier 2 that are specific to the problem being addressed. The chosen indicators are compared before and after management actions are implemented.

Regulatory monitoring of permitted entities is included in this category. Effluent monitoring helps WDNR determine whether permitted entities are meeting their permit conditions and state regulations. This type of monitoring is often done through self-reporting by the permitted entities, combined with spot-checks by WDNR staff. Monitoring of receiving waters assesses what the effect of an effluent is on the water quality in the receiving waterbody. This monitoring helps determine whether current effluent limits are appropriate or should be altered. Monitoring of public drinking water wells is carried out to ensure that surface and groundwater meet federal public health standards for contaminants in drinking water.

Clean Water Act (CWA), Fisheries, and Public Trust Doctrine Objectives

One purpose of this *Strategy* is to create a more efficient match between our current monitoring programs and objectives found in the Clean Water Act, Fisheries Acts, and the Public Trust Doctrine. It is important to note that in addition to revising our water monitoring programs, the WDNR is concurrently refocusing efforts to meet these three categories of objectives. One component of this effort is the establishment of more comprehensive procedures for ensuring statewide consistency in a number of CWA program areas.

Protocols are in development for:

- Listing of impaired waters on the 303(d) list and compiling comprehensive integrated 303(d)/305(b) Reports
- Establishing attainable and designated uses for waterbodies
- Evaluating waters to determine whether they are meeting attainable and designated uses

Because many of these efforts are underway in a parallel process, some gaps in the *Strategy* will exist until they are completed. For instance, once the modified 303(d) listing protocol is determined, the core Tier 1 indicators may be modified to reflect that. Throughout this document, those areas in which changes are expected in the near future due to the modification of procedural elements are identified.

The following table indicates which monitoring Tiers primarily contribute to meeting each Clean Water Act, Fisheries, or Public Trust Objective (though it should be noted that most program elements in each Tier address multiple objectives). To provide a more program-specific assessment, broad-based and specific objectives have also been listed at the beginning of each chapter in this document. The *Strategy* was designed to allow appropriate coverage of each of these areas, and will ultimately support the decision-making needs inherent in each.

Table 1. Primary Clean Water Act objectives by Tier.

Clean Water Act Objectives	**Tiers that Primarily Address each Objective:**
Establishing, reviewing and revising water quality standards (303(c))	Tier 2
Determining water quality standards attainment (305(b))	Tiers 1 & 2
Identifying impaired waters (303(d))	Tiers 1 & 2
Identifying causes and sources of water quality impairments (303(d), 305(b))	Tier 2
Supporting the implementation of water management programs (303, 314, 319, 402, etc.)	Tiers 1, 2, & 3
Supporting the evaluation of program effectiveness (303, 305, 402, 314, 319, etc.)	Tier 3
Fisheries Objectives	**Tiers that Primarily Address each Objective:**
Developing quantitative management objectives for specific waters	Tiers 2 & 3
Identifying populations not meeting objectives	Tiers 1, 2, & 3
Compiling input for identifying problem causes	Tiers 1, 2, & 3
Compiling input for developing management recommendations	Tiers 1, 2, & 3
Analyzing general responses to management actions	Tiers 2 & 3
Public Trust Doctrine Objectives	**Tiers that Primarily Address each Objective:**
Developing environmental objectives	Tiers 1 & 2
Monitoring impacts of permitting decisions at the general water level	Tiers 1, 2 & 3

Core Indicators

Core indicators have been identified for each different resource type listed under Tier 1. The core indicators are sampled at every site, or at a subset of sites, within each resource category. They provide a baseline picture of water chemistry, as well as different measures of the effects of stressors (e.g., exploitation, riparian

development, watershed land use, and pollutants) on fishery and ecosystem health. These metrics are easily measured, well understood, and are currently used by Water Division staff. Together, they provide independent and complementary measures of ecosystem structure and function. For individual sites, managers may decide that additional indicators will be added based on designated use categories or specific management needs. As noted above, we expect that these core indicator lists will evolve as procedural guidance elaborates on parameters needed for decision making. Core indicators for Tiers 2 and 3 will be site-specific, depending on the problems identified through Tier 1 sampling or other credible sources.

Monitoring Program Logistics

Each monitoring program described in this document lists information about quality assurance measures, database management, and reporting of data results. Specific databases and reports are described in more detail in the "Monitoring Program Logistics" chapter.

One crucial component of WDNR's unified *Strategy* is the cleaning and integration of our database systems for tracking monitoring results. A new monitoring database system is under construction, which will allow simultaneous access to data from the multiple databases currently in use. The new integrated database, called the Surface Water Monitoring System (SWMS), will allow efficiencies in retrieving complete bodies of data on specific water resources and will allow geospatial mapping of monitoring stations. As a precursor to development of SWMS, the WDNR is undergoing a concerted effort to clean up the backlogged monitoring data that has not yet been entered into the US Environmental Protection Agency's (USEPA's) Storage and Retrieval (STORET) System. The new SWMS system will automate the process for entering information into STORET to prevent such backlogs in the future.

Implementation

The Water Division Monitoring Team and Subteams will each be re-evaluated and reconstituted, to meet on a regular basis throughout the year. These teams will be charged with programmatic direction and evaluation. Subteams will continue to discuss technical details presented here as part of their discussions on how to implement the *Strategy*. A ten-year timeline has been constructed which projects critical projects for each Subteam and their expected completion dates. A detailed budget analysis has also been conducted to determine the level and source of funding currently allocated to each monitoring program. Budget information will be further assessed by the administrative Monitoring Team to determine whether shifts in funding are appropriate to meet the goals of this *Strategy*.

The WDNR is committed to using citizen volunteers to increase efficiency in collecting data for use in management decisions. A Citizen Monitoring Subteam will be created to determine the most appropriate ways to incorporate this under-used resource. Initial discussion and evaluation of this concept has been provided as the *Draft Citizen Monitoring Proposal* in Appendix A.

Prioritization of Future Efforts & Emergency Planning

The Water Division has identified several priority program areas for enhancement should more funds become available. These priorities include: establishing a statewide volunteer coordinator, increasing TMDL 303(d) listing efforts, increasing efforts toward a formal stream classification monitoring system, and chemical analyses of waters receiving effluents from permitted entities. Additional areas for enhancement are inland beach pathogen monitoring, contaminated sediments, wetlands, and TMDL source loading monitoring.

In recognition that occasional episodic events will require immediate assessment and action, the Water Division Monitoring Team will delineate a process for addressing emergency issues such as public health crises, hazardous spills, or other environmental emergencies. This will entail a system by which Water Division Bureau Directors and Section Chiefs can call immediate meetings of the Monitoring Team to redirect staff effort and funds to address crisis issues.

TIER 1: STATEWIDE BASELINE MONITORING

Trend establishment & problem identification

Historically, ecological monitoring and ambient water quality monitoring have been conducted independently of one another, resulting in duplications of staff effort and incomplete and inconsistent support of water quality data needs. Tier 1 monitoring is being restructured to incorporate both ecological monitoring and ambient water quality monitoring in a coordinated sampling effort to improve efficiencies and more adequately supply data that is needed for management decision-making.

Tier 1 monitoring is organized by resource type. For each type of resource (coldwater and warmwater streams, rivers, lakes, wetlands, Great Lakes, the Mississippi River, and groundwater), sampling sites will be chosen annually according to designs constructed to best evaluate that resource. Monitoring subteams are already in place for most of these resource types. The monitoring subteams will meet the following goals:

- Annually establish a sampling schedule for each resource type, appropriate to meeting the specific data needs for that resource.
- Meet on a regular basis to ensure that the sampling design is being adhered to and that goals and data needs are being met.

A provisional suite of sampling parameters has been established for each resource type. Once each sampling site is chosen, it will be individually evaluated to determine which additional parameters will be sampled for, depending on variables specific to each location.

LAKES[1]

Author: Tim Simonson

Status: Currently in Place

This program has been in place since the late 1990's.

Monitoring Objectives

Clean Water Act Objectives

- Determining water quality standards attainment
- Identifying impaired waters
- Supporting the evaluation of program effectiveness
- Establishing, reviewing and revising water quality standards

Fisheries Objectives

- Developing quantitative management objectives for specific waters
- Identifying populations not meeting objectives
- Compiling input for identifying problem causes
- Compiling input for developing management recommendations
- Analyzing general responses to management actions

Public Trust Doctrine Objectives

- Developing environmental objectives
- Monitoring impacts of permitting decisions at the general water level

Other Specific Objectives

Lakes monitoring is designed to achieve the following:

- A spatial and temporal inventory of the health and condition of statewide lake resources.
- A screening tool to initiate more in-depth field investigations to confirm apparent water quality or fisheries problems.
- Standardized methods and data to evaluate statewide management activities.
- A context for comparing data collected among lakes and the capability to compare similar lakes to each other.
- An inventory and distribution of common fish species in the state.
- Effective surveillance for nonindigenous/invasive species occurrence.
- Synoptic data on the impacts of stressors (e.g., riparian and watershed land use, angling) on fish communities and trophic status.

[1] In addition to the baseline lake monitoring programs described here, there are also a few inland lake sites that have public drinking water intakes that are monitored according to the Safe Drinking Water Act. These include four sites on Lake Winnebago, and one site on Rainbow Lake. These surface water drinking intakes are monitored using the same protocols as described in the Public Drinking Water Well Monitoring section in Tier 3.

- A comprehensive data set on the state's lakes that can be used for project planning and individual lake assessments
- Inferences on the condition of non-sampled lakes.
- Information on the attainment status of lakes for aquatic life use designations.
- Integration of existing Water Division monitoring programs.

Monitoring Design

The Baseline Lakes Monitoring Program focuses primarily on assessing status of large lakes, defined as lakes > 100 acres in surface area with public boat access (including large river impoundments). Sampling of small lakes (< 100 acres with public boat access) is included on a reduced scale due to staff and funding limitations.

Previously, all 840 large lakes had been sampled on a six-year rotation (140/year); each lake was scheduled for sampling once every six years. Of the 1040 small lakes, the number sampled (33/year) was based on the number of staff available within a Fisheries Team. Generally, at least one small lake was done by each biologist every year. Sampling schedules were developed to ensure that a full range of lake classes were sampled for small lakes.

WDNR is proposing to combine the 6-year rotation with random sampling. In areas with relatively few lakes, the 6-year rotation will likely continue. In areas with many lakes, random sampling will be done. At a minimum, we will sample a total of 110 lakes annually, according to the following categories: 50 small lakes and 60 large lakes. Random sampling will occur without replacement for a 6- year period and then restart another random 6-year rotation to allow for lakes to be picked again in the next cycle. We have not discussed the need for reference sites.

In addition to the sampling design above, water quality monitoring is being conducted on 65 Long-Term Trend (LTT) lakes statewide to monitor long-term trends and provide regional reference conditions for each defined lake class. These lakes will be used to characterize within-lake and among-year variability in baseline water quality monitoring (see the Surface Water Quality section of the *Strategy* for details). A program is also proposed for monitoring pathogens (*E. coli*) at high-use inland beaches (see the Pathogen Monitoring on Inland Beaches section).

Core and Supplemental Water Quality Indicators

The following metrics will be sampled in lakes to monitor the attainment of the listed designated uses. Each parameter is sampled only once per sampling season, though because individual parameters need to be sampled during specific time frames more than one visit per lake is often needed.

Table 2. Metrics for Baseline Lakes sampling.

Designated Use Supported	Metrics Sampled for Lakes	
	Small (<100 acres)	**Large (>100 acres)**
Fish & Aquatic Life	FQI (floristic quality index)	IBI (index of biotic integrity)
	TSI (trophic status index) Fish CPE (catch per unit effort) Invasive Species Inventory	
Public Health & Welfare	Fish Tissue – mercury & PCBs (selected sites)	

Trophic Status Index (TSI): Satellite imagery will be used to determine water clarity for all lakes simultaneously on a regular basis. Trophic status indices will be computed from regression models. Lake Self-Help volunteers calibrate images by completing Secchi disk transparency measurements for a sub-sample

of all lake classes on the same days as satellite photos are taken. Means and ranges of the TSI will be computed for lake classes. Individual lakes will be compared to expectations derived from each lake class data set, to determine lake health. Volunteers will also assess pH and dissolved oxygen and temperature profiles during the period of peak summer stratification on a sub-sample of lakes. Trends in Secchi depth, phosphorus, and chlorophyll *a* will be determined on a fixed set of approximately 150 lakes monitored by volunteers.

Fish Community Characteristics: The characteristics of littoral zone fish assemblages have proven to be sensitive indicators of in-lake, riparian, and watershed land use changes on large lakes. Littoral zone (non-game) fish assemblages are sampled primarily in the summer with mini-fyke nets. In addition to using traditional metrics such as species richness, a fish IBI (Index of Biotic Integrity) is being developed. This type of index can be calibrated to reflect water quality-related problems.

Floristic Quality Index (FQI): The characteristics of the aquatic plant community are excellent indicators of in-lake, riparian, and watershed health for lakes. This metric is used primarily on small lakes, and is assessed once during the summer.

Gamefish Population Dynamics (Fish CPE): The relative abundance of all fish species sampled, as well as recruitment, population size-structure, and age and growth is determined for targeted gamefish populations. Gamefish sampling is conducted primarily during the fall using boat electrofishing. Temperature and conductivity are recorded when electrofishing occurs.

Contaminants: Selected lakes are screened for mercury and polychlorinated biphenyls (PCBs) in the fish tissue.

Water Quality Parameters: Water quality monitoring is being conducted on 65 lakes statewide to monitor long-term trends and provide regional reference conditions for each defined lake class. These lakes will be used to characterize within-lake and among-year variability in baseline water quality monitoring. See the Surface Water Quality section of the *Strategy* for details.

Pathogen Indicators: *E. coli* is an indicator of the presence of fecal matter in water and is used as a tool to help protect humans from waterborne exposure to dangerous pathogens associated with feces. *E. coli* may be sampled at select high-use beaches. See the section on Pathogen Monitoring on Inland Beaches for more details.

Quality Assurance

The WDNR has a quality management plan (QMP) and an Evaluation System Manual Code (MC 9314.1) in place that establishes processes and protocols that the state's monitoring program must meet. The QMP is scheduled for review and revision by 6/30/05, and quality assurance processes may be added or modified as needed.

Standard monitoring protocols are distributed to all staff participating in monitoring. Protocols and data sheets are also accessible at any time on our network and web-based database. Training of field staff for consistency in data collection and recording is critical to the success of the monitoring program. Training in taxonomy, deployment of field gear, and general program implementation is periodically made available to all staff. A layer of quality assurance to maximize data integrity through a data screening process is built into the statewide database. All monitoring protocols employed, at a minimum, meet the Department's data standards as developed by the Aquatic and Terrestrial Resources Inventory (ATRI) Team. The State Lab of Hygiene, a certified laboratory with approved quality assurance procedures, completes most water quality analyses.

Data Management

An internet-based electronic data storage system following state geo-locational standards is used to manage fish and habitat data (http://infotrek.er.usgs.gov/wdnr_bio/). Water quality data are managed on an accessible, internet-based electronic data storage system following state standards for geo-location (http://dnr.wi.gov/org/water/fhp/lakes/lakesdatabase.asp). These data are accessible to the public. In 2005-06, the SWMS project (through a potential National Environmental Information Exchange Network (NEIEN) Grant) will facilitate the flow of data from the United States Geological Survey (USGS) server through SWMS to the USEPA STORET system. Contaminant data are managed on a client-server system and are available upon request.

Data Analysis/Assessment

Probability-based subsampling of core indicators from all waterbody classes within the geographical scale of interest will allow inferences to be made for all waters within the area on a basin, ecoregional, or statewide scale. Attainment of standards for lakes is determined relative to the baseline condition for the core indicators in Tier 1. Baseline condition is set by lake-type within a lake classification framework. Lakes with any metric falling below the 25th percentile are flagged as "non-attainment" lakes. These lakes are prioritized based on the degree (how far below the 25th percentile) and extent (how many metrics below the 25th percentile) of non-attainment and more intensive sampling, under Tier 2, is completed in priority order.

Reporting

Lake status is reported in the 305(b) Report (future integrated 303(d)/305(b) Report). Biennial administrative reports are produced describing the work accomplishments of the monitoring program. Reports on the health and condition of waterbodies and their fisheries are also produced.

Programmatic Evaluation

The Baseline Monitoring Program operates within the framework of the Water Division biennial workplan. Each Subteam (i.e., lakes, rivers, streams, etc.) meets annually to review the protocol, strategy, and products of the sampling program to ensure that it is meeting the needs of resource managers. Any changes to the protocol or strategy are recommended to the Water Division Monitoring Team. Reviews of workplan performance are completed annually, to evaluate job completion.

General Support and Infrastructure Planning

Staff & Training – Approximately 10 FTEs participate in the Lakes sampling. Integrated Science Services (ISS) supports several baseline components; ISS staff also serve on the Lakes Baseline Monitoring sub-team. Volunteer monitors in the Self-Help Lakes program provide a significant amount of data to support this program.
Laboratory resources – None.
Funding – This program is funded under Sport Fish Restoration at approximately $230,000 annually. Total estimated support, including permanent salaries, fringe benefits, and other indirect costs is approximately $600,000 annually.

Program Gaps

The development of a Lake Index of biotic integrity (IBI) for Wisconsin is an outstanding need that Lakes staff are working to complete. An IBI was recently developed for some Minnesota lakes, which will be adapted for Wisconsin lakes. With the Baseline data collection effort that has been completed to date, data are now available to finalize this effort.

SELF-HELP LAKE MONITORING

Author: Jennifer Filbert

Status: Currently in Place

This program has been in place since 1986.

Monitoring Objectives

Clean Water Act Objectives

- Establishing, reviewing and revising water quality standards
- Determining water quality standards attainment
- Identifying impaired waters
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Self-Help Lake Monitoring, coordinated by the Department of Natural Resources and the University of Wisconsin-Extension in cooperation with Wisconsin Association of Lakes and lake groups, assesses the chemical, physical, and biological quality of selected Wisconsin lakes statewide. The overall goal of Self-Help Lake Monitoring is to train and equip a network of citizen volunteers who provide useful information for the ongoing protection of Wisconsin's lakes. The objectives of Self-Help are:

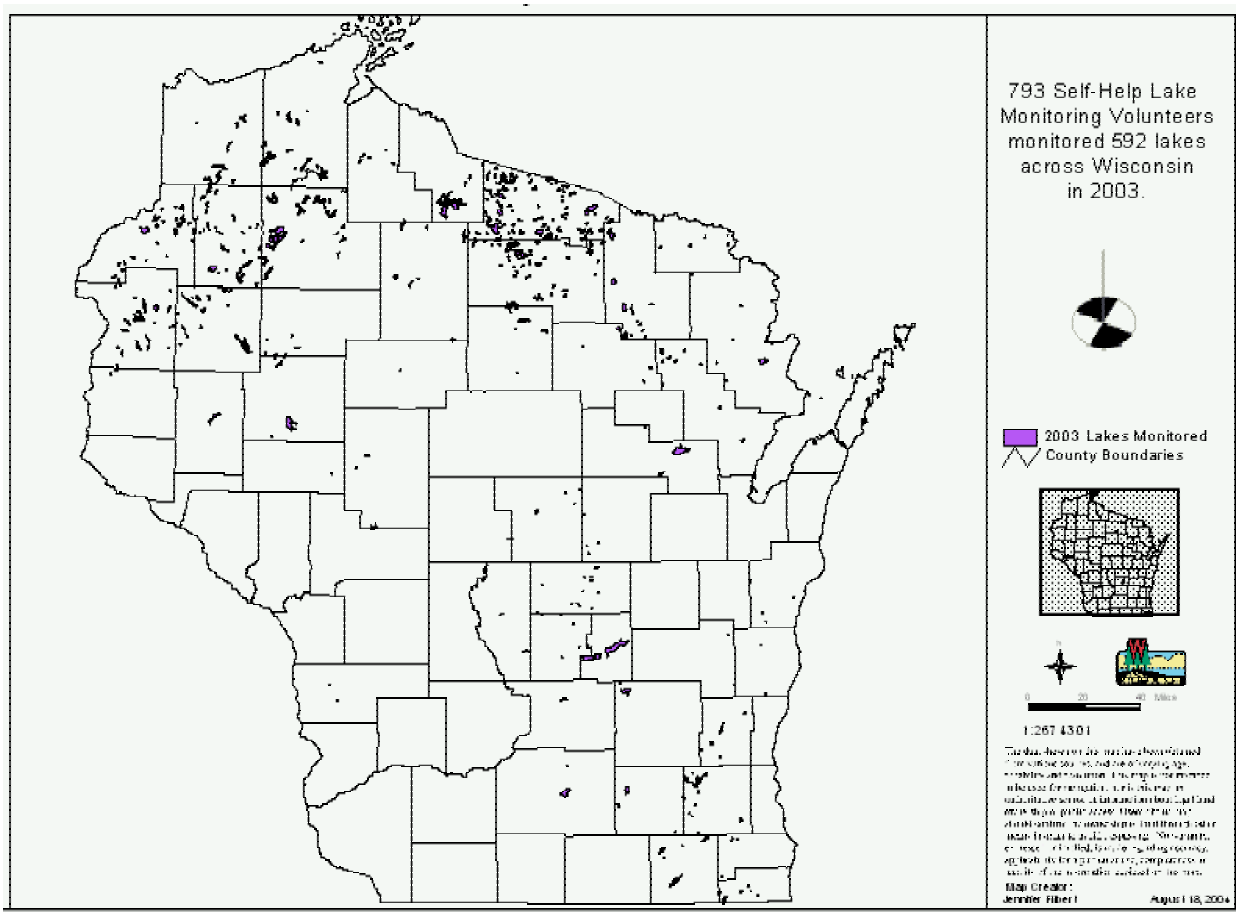
- Quality / Accessible data
- Shared / Useful results
- Educated and informed citizen lake monitors (lakes and issues)
- Greater number and frequency of lakes monitored
- Enhanced participation in statewide network
- Quality and sufficient staff support
- Reduced administrative overhead (state, community & citizen)
- To engage others in support of network
- Tie-in to lake research and national monitoring
- Recognize and appreciate citizen involvement

Monitoring Design

Self-Help volunteers monitor over 600 lakes throughout Wisconsin (Figure 1). Generally, the volunteer expresses interest in monitoring a particular lake they live on or visit frequently. Self-Help Lake sites sometimes overlap with those sites chosen for baseline monitoring, but primarily the Self-Help sites provide a large body of additional sites beyond those sampled through the baseline program. Baseline staff and Self-Help staff coordinate at the beginning of each sampling season to remove redundancy in sampling.

Self-Help provides equipment and training to the volunteer. In the past this has usually been done one-on-one by region staff. In the future, training will be more commonly done through group training sessions or short courses offered at local technical colleges. Self-Help provides each volunteer with an instruction manual. The instruction manual is currently being rewritten, with the new version expected out spring 2005.

Figure 1. Lakes monitored by Self-Help Lake volunteers in 2003.



Core and Supplemental Water Quality Indicators

- Most volunteers begin their involvement as a water clarity monitor, using a secchi disc. Water clarity monitoring is usually conducted every other week from approximately April/May to October.
- After a year of secchi monitoring, some volunteers choose to monitor D.O., temperature, total phosphorus and chlorophyll *a*. Additional training and equipment is provided at this point. Temperature and dissolved oxygen are measured using a variety of field equipment. Total phosphorus and chlorophyll *a* are measured through the volunteers collecting water samples in the field and sending them to the State Lab of Hygiene for analysis.
- Some volunteers also monitor aquatic plants, and some monitor invasive species, including purple loosestrife, zebra mussels, curly leaf pondweed and eurasian watermilfoil.

Quality Assurance

Self-Help does not currently have an official Quality Assurance Project Plan (QAPP). However, one will be developed in the coming years.

Data Management

Volunteers report data through either 1) an online form with a personal user id and password, which appends the data directly into the DNR's Lake Water Quality database; or 2) the Secchi touch-tone telephone line. Other data are regularly transferred from the State Lab of Hygiene into the Lake Water Quality database. The DNR Lake Water Quality database contains data collected by volunteers, as well as DNR baseline lake data and data collected through lake grants. Currently data from 1999 to present is available in this web accessible database. Past data is continuously added as time allows. Self-Help data is fed nightly into the Waterbody Assessment Display and Reporting System (WADRS), to populate information on the trophic state of lakes for use in waterbody assessment.

Data Analysis/Assessment

Self-Help data has been used for:

National Information and Statewide Reporting

Water Quality reports to Congress: Citizen generated information is used every two years to report trends in Wisconsin lakes and to identify needs to the federal government. Great American Secchi Dip-in: Citizen data is collected and analyzed with other data collected nationally to report lake clarity.

Lake and Basin Assessment and Planning

Numerous lake diagnostic and feasibility studies: Citizen data is used for before and after documentation, as well as to show severity of water quality problems and to set restoration goals. Examples include Delavan Lake, Fox Lake, Bass Lake, Big Green Lake, and Devils Lake.
Annual condition reports to individual lake groups and media: Citizen data is summarized and presented annually by volunteers to lake organizations and to the local media to show water quality trends.
Watershed and Basin Plan preparation: Citizen lake data is summarized in tables and used to express lake water quality conditions and trends. This information is used to set priorities for lake protection, restoration, and funding.

Requests to Wisconsin Legislature

Request for a phosphorus water quality standard: Citizen data was used to show trophic status of WI lakes to demonstrate the need to limit the phosphorus being discharged from wastewater treatment facilities and to support a ban on phosphate detergents in WI. This legislation was later passed.
Request for Aquatic Invasive Species Funding and Legislative Language: Volunteer data was utilized to help prepare statewide lists and maps of new invasions of zebra mussels and Eurasian Water milfoil in support of the department's request for funding and policy. We were successful in gaining $300,000 per year for watercraft inspection, invasive species education, monitoring and biological control of purple loosestrife; and strong legislation prohibiting the launching of watercraft with aquatic plants or zebra mussels attached.

Satellite Research

The University of Wisconsin's Environmental Remote Sensing Center (ERSC) and Self-Help have been partners in Remote Sensing research since 2000. ERSC is using satellite images in conjunction with Self-Help data to develop a set of algorithms to predict basic water quality parameters from LANDSAT data. Collecting sufficient lake data on the variables of interest on dates concurrent with satellite overpass dates would be impossible without volunteer involvement.

Long Term Ecological Trends of Northern Temperate Lakes--Kathy Webster, Ph.D. UW-Madison:

This research used 11+ years of Self-Help data from a set of 50 Wisconsin Long Term Trend Lakes. The data was analyzed to look for trends in individual lakes over the 11-year period. In this research, only four lakes showed long-term trends in two or more water quality variables (chlorophyll *a*, total phosphorus, or Secchi

depth). However, significant inter-annual variation was observed.

Reporting

At the close of each Self-Help season (data must be turned in by November 1), Annual Reports are prepared on each lake and are sent to each volunteer. The Annual Reports are available on the Self-Help website, along with up-to-the minute reports. Every several years statewide and regional summary reports are also prepared and made available on the web. Self-Help data also contribute significantly to the biennial integrated 303(d)/305(b) report statistics on trophic state.

Programmatic Evaluation

Periodically staff from Central office and the regions, who are involved with Self-Help meet to discuss Self-Help protocols and the manuals.

General Support and Infrastructure Planning

Self-Help is funded through contracts in lieu of individual lake grants. Several DNR central office staff and staff in each DNR region contribute time to Self-Help regularly in addition to other duties.

The budget is approximately $87,000/year.

References

Self-Help Website: http://dnr.wi.gov/org/water/fhp/lakes/selfhelp/

RIVERS

Monitoring of Wisconsin's large (non-wadeable) rivers is composed of three primary components: Biotic Integrity, Long Term Trend (LTT) monitoring for ambient water quality, and Flow Gaging.

In the 1930s, USGS established a network of over 100 flow gaging stations in Wisconsin. The WDNR contributes funds towards the operation of several of these stations. In 1991, LTT monitoring was established at 42 of these flow gaging stations for sampling water chemistry parameters in rivers. Starting in 2000, fish assemblages were assessed as part of Biological Integrity monitoring to measure river and overall ecosystem health. Initially the rivers of interest were primarily those undergoing hydropower dam relicensing through the Federal Energy Regulatory Commission. Starting in 2002, Biological Integrity monitoring was expanded statewide and 29 sites overlapped with LTT sites. Ultimately 86 fish index of biotic integrity (IBI) runs and 44 gamefish-endangered-threatened species (GET) surveys were conducted on 32 rivers in 2002. The Biotic Integrity program monitored 94 IBI sites and 54 GET sites on 33 rivers in 2003.

BIOTIC INTEGRITY MONITORING

Author: Brian Weigel

Status: Currently in Place

The current strategy has been in place since 2002.

Monitoring Objectives

Clean Water Act Objectives

- Determining water quality standards attainment
- Identifying impaired waters
- Supporting the evaluation of program effectiveness
- Establishing, reviewing and revising water quality standards

Fisheries Objectives

- Developing quantitative management objectives for specific waters
- Identifying populations not meeting objectives
- Compiling input for identifying problem causes
- Compiling input for developing management recommendations
- Analyzing general responses to management action

Public Trust Doctrine Objectives

- Developing environmental objectives
- Monitoring impacts of permitting decisions at the general water level

Other Specific Objectives:

- Help determine which management efforts to pursue if a river's potential is not being attained
- Establish geographic trends in river quality
- Identify long-term changes in ecological integrity or game fish characteristics
- Characterize the performance of management actions

- Classify rivers by natural environmental features and subsequently identify reaches that are not sampled at the appropriate intensity
- Develop a macroinvertebrate sampling and assessment protocol for indicating biotic integrity, with the potential for use in establishing biocriteria of rivers
- Identify the performance characteristics of fish IBI monitoring after collecting annual data for 5 years (through 2007 field season). Analyses will identify the variability in IBI scores at least-impacted and degraded sites, suggesting how frequently sites should be sampled in the future.
- Characterize the performance of the GET procedures after collecting annual data for five years (through 2007 field season). Analyses are intended to derive expectations for species-specific gamefish catch per unit effort (CPE) on different river kinds and gear. Subsequently modify GET procedures as appropriate.
- Foster the development of biocriteria, habitat indices, and baseline data for rivers

Monitoring Design

The strategy demands broad spatial and strong temporal components to function optimally. Being statewide in scope, this monitoring effort must be employed over a broad spatial scale to characterize the variety of Wisconsin's river types, and the kinds and intensities of human disturbances upon each river type. The effort necessitates a strong temporal component to evaluate trends in river health, game fish biostatistics, and management over time. Some river reaches have a special local importance because, for example, they are popular fisheries, experiencing development pressures, or under consideration for management changes in fishing regulations, dam operations, or habitat structure. For the 2005 and 2006 field seasons, the Rivers Subteam prioritized 108 IBI sites and 54 GET surveys on 33 rivers statewide, most of which were sampled during the two years prior. The strategy targets one site per 9 – 18 river km (15-30 river mi). The program focuses on riverine and slightly impounded reaches only (larger impoundments are sampled by the Lakes program). Additional reconnaissance sites may be added as prioritized by Regional staff and the Rivers Subteam.

All river sites will be sampled annually, for the first 5 years of the program, through 2007. Then data analyses of metric sensitivity, natural environmental variability, and trends will allow refinement of sampling efforts. A subset of high priority sites will likely be sampled annually where there are high-profile fisheries, reference sites, or to closely monitor at-risk sites. Samples are taken only once per summer.

Core and Supplemental Water Quality Indicators

Since 2002, efforts at these sites have focused primarily on fish, with a brief habitat assessment, plus macroinvertebrate sampling at 42 sites per year. Conductivity, pH, dissolved oxygen, temperature, and turbidity are to be measured prior to fish sampling. WDNR is now proposing that water chemistry be added to the suite of parameters sampled at those sites where it is not already being collected as part of the LTT network (see Surface Water Quality section of the *Strategy*).

Fish Assemblage Characteristics: The standardized fish shocking protocol for calculating the fish-based IBI on warmwater rivers of Wisconsin enables the determination of river health and game fish statistics simultaneously (Lyons et al. 2001). Every site must be sampled according to IBI procedures. The protocol requires sampling main-channel-border habitats, which are relatively shallow shoreline areas along the river channel that carry the majority of the river flow. Depending upon the project goals, it may be informative to sample the borders of major side channels if the channel carries a substantial amount (> 15%) of river flow. Standard shocking occurs in daylight and in a downstream direction as close to the shoreline as possible. Each site is to be sampled for 1.6 km of contiguous shoreline, a distance at which estimates of species richness were asymptotic and insensitive to variation in sampling effort. Fish collections are made between mid-May and late September. Sampling should be avoided if the river stage is > 1m above normal, but it can occur during below-normal flows.

Standard equipment is a boat-mounted, pulsed-DC electrofishing unit. Typically a 5m-long aluminum boat powered by a 15-25hp outboard motor, with the boat hull serving as the cathode, works well. The anode is a single 4m boom with a "Wisconsin ring" from which 16 cylindrical, 17mm-diameter stainless steel droppers are suspended. In normal operation, about 125mm of each dropper is in contact with the water. A gas-powered generator rated at ~3500 W provides adequate electricity. The control box converts AC to DC and allows standardization of the pulse rate at 60 Hz and a 25% duty cycle. Depending upon water chemistry, sampling can typically be done at ~3000 W output from the control box.

While sampling, a single person uses a 17mm-mesh (stretch) dip net and attempts to capture all of the fish seen. This mesh size consistently retains fusiform species such as cyprinids >75mm total length and longitudinally compressed species like centrarchids >50mm, but smaller individuals are often collected. Sampling techniques are biased are against small (e.g., cyprinids) and nocturnal species (e.g., catfish, walleye), but collect large numbers of suckers and centrarchids, including smallmouth bass. Captured fish are identified to species, counted, and weighed. Game fish should have individual lengths and weights measured, but other species do not need length information and can be weighed in aggregate.

Gamefish, Endangered, and Threatened Species (GET) surveys: A more extensive gamefish, endangered, and threatened species survey is conducted to address fisheries management concerns. Game fish assessments typically target one species and are tailored to meet the management goals for individual rivers. The most anticipated species of management concern include *Micropterus dolomieu* (smallmouth bass), *Stizostedion vitreum* (walleye), *S. canadense* (sauger), *Ictalurus punctatus* (channel catfish), and *Pylodictis olivaris* (flathead catfish). If the primary game species of management concern is smallmouth bass, then IBI electrofishing runs may yield data efficiently. Species-specific sampling protocols include extended daytime electrofishing, nighttime electrofishing, tailwater electrofishing in the fall, and hoop netting.

Extended daytime electrofishing. If enough game fish individuals are not caught after the 1-mile IBI run for estimating population dynamics, then it may be useful to extend the shocking run to sample an additional 1 – 4 miles. Collect and process all game, threatened, and endangered species.

Nighttime electrofishing. Nighttime shocking poses many logistical and safety concerns, particularly in reaches with poor access, numerous obstructions, or fast, turbulent water. However, if nighttime shocking is opted for then site reconnaissance during the day is encouraged. Studies indicate that night shocking yields more total fish species and biomass than day shocking (for references see Lyons et al. 2001). Most game species are found in greater number, and larger individuals are caught during nighttime sampling compared to daytime. The catch differences are pronounced for walleye, sauger, catfish, and esocids, but somewhat less notable for centrarchids.

Fall tailwater electrofishing. Fish migrations to tailwater areas for intense fall feeding or overwintering pose an opportunity to collect walleye, sauger and esocid data efficiently in some river systems. Consider electrofishing during the daytime if the site poses serious logistical and safety problems, but nighttime shocking may provide higher catch rates. The optimal time of year to sample may vary by river and weather conditions but mid- to late-October is probably appropriate. On the Lower Wisconsin River for example, fall tailwater electrofishing at night is much more efficient than summer IBI runs for collecting walleye, sauger, and esocid data. The walleye catch rate jumps from ~15 fish/hour during summer runs to ~300 fish/hour during fall tailwater sampling.

Hoop netting. Catfish can be targeted by sampling with hoop nets. Sampling during spring migration typically maximizes catch rates. The optimal time for spring sampling varies by river and weather conditions but it generally ranges from mid-March to mid-May. Depending on management interests, a summer sampling option may be preferred to focus on resident fish. Vokoun and Rabeni (2001) provide a standardized hoop net sampling protocol for sampling channel catfish in prairie streams. Pellett et al. (1998) discuss channel catfish movements and sampling procedures they found useful on the Lower Wisconsin River. Protocols for catfish sampling can be explored by Regional staff and the Rivers Subteam on a river-specific basis.

Water Chemistry: Water temperature, dissolved oxygen, pH, conductivity, and turbidity are measured prior to fish sampling. In addition, select parameters identified in the Surface Water Quality section of this document will be sampled at a subset of sites.

Contaminants: Rivers are screened for mercury and PCBs in the fish tissue.

Pathogen Indicators: *E. coli* is an indicator of the presence of fecal matter in water and is used as a tool to help protect humans from waterborne exposure to dangerous pathogens associated with feces. *E. coli* may be sampled at select high-use beaches. See the section on Pathogen Monitoring on Inland Beaches for more details.

Habitat Assessment: Assessments of channel morphology, flow, bank features, fish cover, substrate, and riparian land cover are made along the 1.6 km IBI station.

Macroinvertebrates: Macroinvertebrate assessment in large rivers promises a cost-effective method to track changes in water quality and river management over time. In general, fish and macroinvertebrate assessments compliment one another because fish tend to respond primarily to habitat, whereas macroinvertebrates are more closely linked with water quality. A successful macroinvertebrate IBI will be worked into the standardized strategy for Baseline-Rivers Biotic Integrity monitoring.

Macroinvertebrate IBI Approach:

1. Select sites to characterize the variety of Wisconsin's river types, and the kinds and intensities of human disturbances upon each river type. Sites having water quality sampling programs in place (e.g., Long Term Trend, USGS/WDNR Nutrient Study) will be selected first because the water quality data gives an assessment of river condition independent of the biota.
2. 42 sites are to be sampled during each of the 2003, 2004, and 2005 field seasons.
3. A river condition assessment based on habitat will parallel the independent assessment used for developing the fish IBI (Lyons et al. 2001).
4. Collect macroinvertebrates (primarily aquatic insects) over a 6-week period during the summer using modified Hester-Dendy artificial substrate samplers. These samplers yield quantitative measures because they have a known surface area. Macroinvertebrates will be preserved in the field and brought to the laboratory for processing.
5. Laboratory processing includes a grid-pan subsorting procedure (sensu Hilsenhoff 1987) to select ≥500 individuals systematically, and a large-rare sort (sensu Vinson and Hawkins 1996) to select for additional taxa. Identify the macroinvertebrates to the lowest taxonomic level possible, usually species.
6. Enter macroinvertebrate data in a database, and calculate approximately 25 potential metrics (e.g., Hilsenhoff Biotic Index (HBI), species richness, % ephemeroptera/plecoptera/trichoptera (EPT) genera and individuals, feeding function proportions, etc.).
7. Using only the least impacted sites, each metric will be tested with a general linear model to see if it responds to natural environmental factors (e.g., river size, dominant substrate, etc.). Any significant influence of natural environmental factors on metric scores will be accounted for in further testing.
8. Test each metric against the independent measure of river condition using a general linear model to identify if the metric can detect ecological impairment. Approximately 10 metrics that detect impairment and represent different levels of the macroinvertebrate assemblage will be incorporated into an IBI. Use summary statistics to calibrate individual metrics.
9. Develop IBI scoring criteria based upon summary statistics.
10. Validate the IBI with an independent set of sites, approximately 1/3 of the data available.
11. Publish a macroinvertebrate IBI manuscript, and implement the IBI within the Baseline Monitoring Program.

Quality Assurance

The WDNR has a quality management plan (QMP) and an Evaluation System Manual Code (MC 9314.1) in place that establishes processes and protocols that the state's monitoring program must meet. The QMP is scheduled for review and revision by 6/30/05, and quality assurance processes may be added or modified as needed.

Standard monitoring protocols are distributed to all staff participating in monitoring. Protocols and data sheets are also accessible at any time on our network and web-based database. Training of field staff for consistency in data collection and recording is critical to the success of the monitoring program. Training in taxonomy, deployment of field gear, and general program implementation is periodically made available to all staff. A layer of quality assurance to maximize data integrity through a data screening process is built into the statewide database. All monitoring protocols employed, at a minimum, meet the Department's data standards as developed by the Aquatic and Terrestrial Resources Inventory (ATRI) Team. The State Lab of Hygiene, a certified laboratory with approved quality assurance procedures, completes most water quality analyses.

Data Management

An internet-based electronic data storage system following state geo-locational standards is used to manage fish and habitat data (http://infotrek.er.usgs.gov/wdnr_bio/). In 2005-06, the SWMS project (through a potential NEIEN Grant) will facilitate the flow of data from the USGS server through SWMS to USEPA STORET. Contaminant data are managed on a client-server system and are available upon request.

Data Analysis/Assessment

Rankings for fish community IBI scores have been developed and calibrated for Wisconsin waters. These IBI rankings use a 0 – 100 scale to qualitatively define waterbodies in very poor, poor, fair, good, or excellent ecological condition. Similar rankings are anticipated for the macroinvertebrate-based IBI as well.

In the near future, as more Baseline Monitoring data is gathered, biotic core indicator rankings will be developed for our more precise river classification. We will then be able to establish expectations for each classification and refine our standards for determining attainment.

After the initial 5 years of the program, we may institute a probability-based subsampling of Best Management Practice (BMP) core indicators from all waterbody classes within the geographical scale of interest to allow inferences for all waters within the area on a basin, ecoregional, or statewide scale.

Reporting

Biennial administrative reports are produced on the work accomplishments of the monitoring program. Local reports on the health and condition of waterbodies and their fisheries are sometimes produced, but there is currently no systematic approach to this reporting and more consistency would be desirable.

Programmatic Evaluation

The Baseline Monitoring Program operates within the framework of the Water Division biennial workplan. Each Subteam (i.e., lakes, rivers, streams, etc.) meets annually to review the protocol, strategy, and products of the sampling program to ensure that it is meeting the needs of resource managers. Any changes to the protocol or strategy are recommended to the Water Division Monitoring Team. Reviews of workplan performance are completed annually, to evaluate job completion.

Sampling methodology will be evaluated in 2007, after 5 years of annual sampling, using analyses of metric sensitivity, natural environmental variability, and trends. These analyses may suggest that sampling should continue annually at the bulk of the sites, or that samples be taken on a 2-3 year rotation. In addition, there may be an opportunity to use a stratified random approach on a subset of sites. Randomization may have to be stratified by river size, dominant substrate, geography, and safe access.

General Support and Infrastructure Planning

Staff & Training – Approximately 1 FTE in the Bureau of Integrated Science Services coordinates the Rivers Biotic Integrity Sub-team. Volunteers will be considered to conduct some of the monitoring in this program, with consideration of accessibility and safety factors.
Laboratory resources – See Surface Water Quality section for lab funding allocated to rivers.
Funding –This program is funded under Sport Fish Restoration at approximately $66,000 annually. Total estimated support, including permanent salaries, fringe benefits, and other indirect costs is approximately $101,000 annually.

Program Gaps

- Lack of a data entry sheet for habitat information.
- Lack of a program to calculate fish-based IBI scores.
- Lack of robust habitat assessment and interpretation procedures.
- Funds for meters to measure in situ water chemistry parameters.
- Staffing sufficient for complete coverage on all high-priority reaches statewide.

LONG TERM TRENDS AMBIENT WATER QUALITY (LTT/AWQ) NETWORK

Author: Jim Ruppel

Status: Currently in Place

Forty two Long Term Trend (LTT) monitoring stations for ambient water quality (AWQ) were established along Wisconsin's rivers in 1991. The stations were chosen as a subset of the long-standing USGS flow gaging stations.

Monitoring Objectives

Data from the LTT Ambient Water Quality monitoring program will be used toward meeting a number of Clean Water Act objectives.

Clean Water Act objectives:

- Establishing, reviewing and revising water quality standards
- Determining water quality standards attainment
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific objectives:

- The primary purpose of this data is to establish a long-term record to determine trends in water quality from a variety of drainage areas and land use types throughout the state.

Monitoring Design

Figure 2 shows the location of the 42 monitoring stations and the total drainage area covered by these stations. The sites for the LTT/AWQ program were selected to represent a wide range of ecological and land use categories. The parameters list was selected to cover water quality parameters that are influenced by changes in land use patterns and have led to or can lead to chronic water quality problems within drainage basins over time. The frequency of sampling varies by site and was determined by looking at past data sets and examining the effects of different sampling frequencies on the strength of trends detected in those data sets. All monitoring is done by field staff and samples are shipped to the State Lab of Hygiene for analysis.

Core and Supplemental Water Quality Indicators

- pH
- Alkalinity
- Conductivity
- Turbidity
- Total Kjeldal Nitrogen
- NO_x
- Ammonia
- Total Phosphorus
- Dissolved Phosphorus
- Total Suspended Solids
- All pigments/ Chlorophyll *a*
- Fecal Coliform
- *E. coli*
- Chloride
- Calcium/Magnesium/ Hardness
- Total Rec. Low Level Metals (11+Hg)
- Triazine
- Dissolved Silica

There have been proposals for a more thorough analysis for fourteen additional pesticides and low-level metals at some of the LTT/AWQ sites. These may be considered in the future as funding allows.

Figure 2. Long Term Trend/Ambient Water Quality Monitoring stations and drainage area

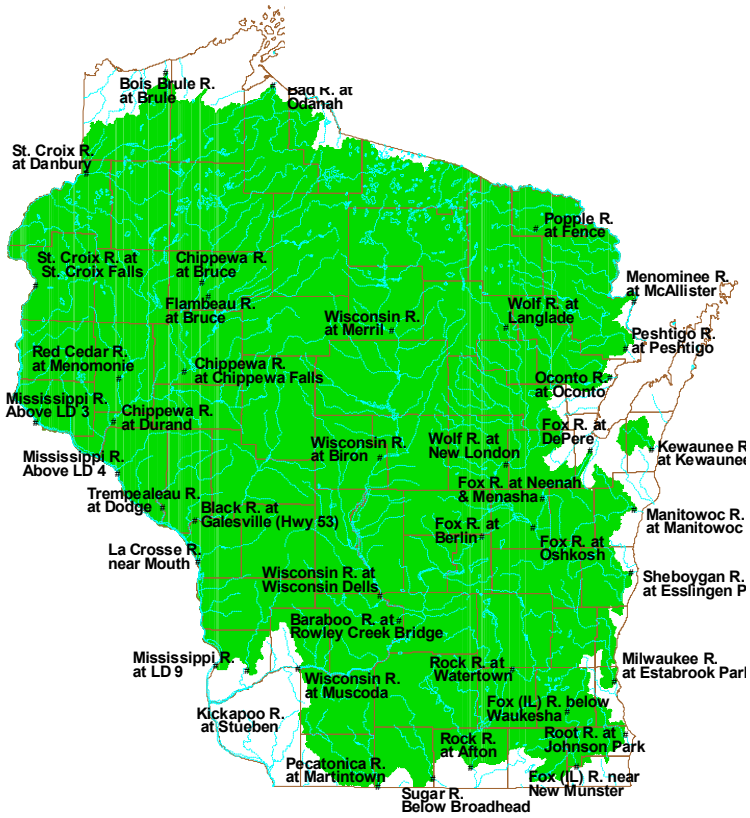


Figure 2. Map of LTT/AWQ Drainage Area

Quality Assurance

A project-specific QAPP is not necessary for this program. However, the sampling protocols and Quality Assurance/Quality Control (QA/QC) sampling requirements are being followed for each of the parameters sampled as part of the LTT/AWQ monitoring program.

Data Management

Samples collected as part of the LTT/AWQ program are submitted to the Wisconsin State Laboratory of Hygiene (SLOH). The analytical results are then placed into the laboratory's database and eventually downloaded into the STORET system by WDNR staff in the Fisheries and Habitat Bureau. All of the station locations are established STORET stations and include latitude and longitude coordinates in their station definitions. Annually the data are queried from State Laboratory database using the Microsoft Access database engine and then exported into a Microsoft Excel database.

Data are available to WDNR staff through the SLOH database soon after laboratory analysis is complete. Data can be downloaded through WDNR's Intranet site via the Lab Data Portal or accessed directly through any database engine that can establish a remote link to an Oracle database. Plans are underway to make the raw data tables as well as statistical analysis of the data available to the general public via the Internet. These data will be migrated to SWMS in 2005.

Data Analysis/Assessment

The primary purpose of this data is to establish a long-term record to determine trends in water quality from a variety of drainage areas and land use types throughout the state. Once water quality data has been collected for a sufficient period of time, the data will be analyzed to determine if trends can be detected indicating a change in mean value of each parameter over time. The ability to detect statistical trends in data is dependent on the deviation about the mean inherent within the data, the magnitude of the change in mean concentrations over a given period of time as well as the ability to filter out confounding factors such as flow conditions, seasonality, and other cyclical influences on the parameters in question.

Water quality chemistry data collected by the program will also be compared to any applicable water quality standards to assess the level of attainment of Wisconsin's rivers. In cases where the water quality parameter concentrations exceed established standards and/or indicate a trend leading toward exceedence of a standard the appropriate water quality managers will be notified so that an increased monitoring plan and, if necessary, a mitigation plan can be adopted.

Reporting

Since the data from the LTT/AWQ program will be made available to WDNR staff & the general public through STORET, the WDNR Intranet, and the WDNR Internet, the data can be used for any number of purposes. These include the integrated 303(d)/305(b) Report, stream classification and use attainability analyses, TMDL development, water quality-based effluent limits in WPDES permit drafting, technical reports, brochure development and television & news media reports. WDNR staff are currently compiling the first report of this LTT/AWQ data, which will be included in the upcoming 303(d)/305(b) Report and updated regularly thereafter.

Programmatic Evaluation

As the program continues, an integral part of the data analysis will be to continually reevaluate the sampling regimen and make adjustments to the sampling frequencies based on the data collected to that point and the ability to detect trends within the data set.

General Support and Infrastructure Planning

Staff and Training: Approximately $11,418 in supplies and a total of 2 full-time employees are needed on an annual basis to conduct the program. However, once the program is through the developmental phase the staff need is likely to decrease. The annual cost of supplies is expected to continue to rise at pace with inflation. Volunteers will be considered to conduct some of the monitoring for this program.
Laboratory Resources:
Approximately $ 110,000 of general agreement lab allocation is needed on an annual basis to support the LTT/AWQ program. This figure is expected to increase at a rate equivalent to the increase in analytical costs at the State Laboratory of Hygiene.
Funding: Laboratory services are funded through general agreement lab allocations between WDNR and SLOH.

References

The sampling and analysis protocols used to collect and analyze the data for the LTT/AWQ program are contained within the WDNR Environmental Sampling & Laboratory Services Guide available on the WDNR Intranet at http://intranet/int/es/science/ls/ or by contacting the WDNR Bureau of Enterprise Information Technology.

FLOW GAGING

Author: Steve Jaeger

Status: Currently in Place

WDNR has been funding selected USGS flow gaging sites since the 1970s. Some USGS sites have data records for over 100 years. USGS supplies all staff time for this monitoring program.

Monitoring Objectives

Clean Water Act Objectives

Because flow gaging data is critical for determining sampling regimes for many other activities, it supports all of the following Clean Water Act Objectives:

- Establishing, reviewing, and revising water quality standards
- Determining water quality standards attainment
- Identifying impaired waters
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific objectives

WDNR's objectives in participating in this cooperative effort are to get high quality continuous flow data that will provide the following:

- Low flow estimates for determining effluent limits for industrial and municipal sources.
- Continuous flow data for evaluating water quality data and calculating annual loads.
- Flood estimates for floodplain determination and zoning.
- Trends in flow that can be used for ensuring that flood predictions consider changes in flow due to development or other land use changes.
- Real time data to determine appropriate times to sample water quality for identification of impaired waters, assessment of management options and evaluation of program effectiveness.
- Stream flow data prior to and at the time of sampling to use in interpretation of water quality data.
- Real time data for the public to assess the safety and appropriateness of rivers for boating, fishing and other recreational activities.
- Flow data to assist in evaluating likely causes of fish kills and human health dangers such as cryptosporidium.

Monitoring Design

WDNR assists in the operation of a statewide network of 126 permanent USGS continuous-stream flow gaging sites, some of which have data records for over 100 years (Figure 3). Many of these sites are also the locations of WDNR's Long Term Trends monitoring stations shown in Figure 2. Though WDNR funds only a portion of these sites, data is available from the entire network of long-term sites. Water-Stage Recorders and Acoustic Velocity Meter (AVM) Systems are used depending on site conditions. All sampling is automated, with water level recorded every 15 minutes. Approximately eight times each year, USGS staff also conduct in-field flow measurements to check the accuracy of the rating curve. Data is downloaded every day. Regressions based on data collected at fixed sites are used to develop estimates of critical flows at needed ungaged locations statewide.

WDNR cooperates with USGS and their other cooperators to select the long-term gaging sites. A major review and planning effort was undertaken by the USGS and their cooperators with support from University of Wisconsin professors in the mid-1990s when funding for the statewide network was being cut by the WNDR due to budget problems. A resulting 1998 UW Water Resources Institute report documented the need and uses for the statewide network and recommended specific sites and funding sources. WDNR funds sites of unique interest to us as well as other sites to provide adequate coverage for development of regressions at ungaged locations.

In addition, temporary flow gaging sites are also established at waterbodies where data is needed for TMDL development. WDNR funds a number of these short-term, typically two-year, sites on an as-needed basis.

Core and Supplemental Water Quality Indicators

- Continuous flows are calculated using gage height measurements or velocity and water depth.
- Temperature is also measured at some sites.

Quality Assurance

USGS methods and standards are used. Having USGS conduct the work assures high quality, readily accessible data that can be used by different users including the public for their various needs.

Data Management

USGS methods and standards are used. Data is stored by USGS and is available to the public through the USGS website and annual publications. Summary flow and velocity statistics will be stored in SWMS.

Data Analysis/Assessment

USGS methods and standards are used.

Figure 3. Statewide locations of USGS flow gaging stations.

Reporting

All data reporting is done by USGS consistent with their national standards and benefits from technical improvements developed as part of their nationwide flow gaging effort.

USGS's website provides complete data access to all cooperators, regulated industries and the general public. Realtime preliminary data provides the ability to see current flows and trends for operation of dams, evaluation of effluent limits on waste load allocated streams, planning of water quality sampling and for recreational needs. Historical data are available in tabular and graphical form for any period of record desired.

USGS also publishes daily average flows for all sites in its annual "Water Resources Data – Wisconsin" reports. Summaries of USGS's

statewide flow monitoring program are also included in USGS's annual reports of projects in Wisconsin as well as DNR's biannual 303(d)/305(b) Report.

Programmatic Evaluation

A major review of the statewide flow-gaging network was published in the above-mentioned "Water Resources Data – Wisconsin" report in 1998.

Annual meetings with USGS and their cooperators are held to review the current status of the statewide effort and to discuss changes in funding ability or priorities of the different groups. DNR's goals are to fund sites that are uniquely critical to our needs as well as to fill in gaps to assure appropriate statewide coverage.

General Support and Infrastructure Planning

Staff – No DNR staff are used for this program; USGS supplies staff for this monitoring. Volunteers could be considered to conduct the in-field flow measurements.
Laboratory – No laboratory costs are associated with this program.
Funding of long-term sites – DNR's funding of a portion of USGS's long-term gaging sites is greatly leveraged by the contributions of other cooperators and by federal match money from USGS. WDNR currently directly funds 14 (12%) of USGS's long-term flow gages at a cost of $77,000. USGS provides 40% match on the operation of these sites. Hydroelectric dam owners fund approximately 20 (18%) additional sites. USGS has been successful at getting other local cooperators to pick up past reductions in funding from the WNDR so the total number of long-term sites has stayed fairly constant, though is subject to change as funding sources fluctuate. WDNR's current goal is to at least maintain the current level of funding with increases to cover inflation while watching for needs that may arise due to new environmental concerns or reductions in funding by other USGS cooperators.
Funding of short-term sites – This year, WDNR has expanded its number of short-term TMDL-related gages to five sites. Installation of a gage is a significant cost that USGS does not cost share (Water-Stage Recorders $12,000 each; AVMs $14,000 each). USGS has offered to cost share the annual operation of these sites at a 25% level (Water Stage Recorders $9,000 each total cost annually, DNR portion $6750; AVMs $10,000 each total cost annually, DNR portion $7,500). This is reduced from the 40% match for the long-term sites due to limitations in the amount of match money available and because these sites are generally of less use to other data users. WDNR's desire is to fund needed TMDL-related sites without reducing support of the long-term sites.

References

"An Integrated Water-Monitoring Network for Wisconsin", University of Wisconsin Water Resources Institute, 1998, WRI SR 98-01.

Water Resources Data – Wisconsin. USGS Water-Data Report WI-98-I.

Water Resources Investigation in Wisconsin. USGS Open File Report 02-300.

STREAMS

Author: Mike Miller

Status: Currently in Place

This program has been in place since 1999. A number of program gaps have been identified and further funds would be needed to address these.

Monitoring Objectives

Clean Water Act Objectives

- Determining water quality standards attainment
- Identifying impaired waters
- Supporting the evaluation of program effectiveness
- Establishing, reviewing and revising water quality standards

Fisheries Objectives

- Developing quantitative management objectives for specific waters
- Identifying populations not meeting objectives
- Compiling input for identifying problem causes
- Compiling input for developing management recommendations
- Analyzing general responses to management actions

Public Trust Doctrine Objectives

- Developing environmental objectives
- Monitoring impacts of permitting decisions at the general water level

Other Specific objectives

- Establish geographic trends in stream quality
- Develop a stream classification system to develop expectations for different stream types
- Refine physical, chemical and biological assessment tools, to improve stream resource characterization and sensitivity to detect impairment
- Develop a rigorous data quality assurance and quality control system
- Improve electronic data capture and automated reporting

Monitoring Design

From 2000-2004, the Baseline Wadeable Streams Monitoring Program incorporated a targeted sampling design where Region biologists dispersed their sampling effort among streams of differing size (stream order) and temperature regimes (cold water and warm water fish communities). Beginning in the 2005 field season, a probability-based sampling design will be incorporated to select stream assessment reaches from stream classes (groupings of streams with similar ecological potential). WDNR's goal is to achieve comprehensive assessment of all of the state's stream resources. Given the large number of small streams in Wisconsin, it will be necessary to sub-sample these populations of streams, where as it may be possible to census populations of higher order streams (Table 3). Data gathered from sub-sampled 1st and 2nd order streams will be used to make inferences for all small streams within their respective classes. If necessary, third order and larger stream populations will be sub-sampled and inferences made of physical, chemical, and biological integrity for all larger streams as well. Sub-sampling designs will be developed to meet specific data quality objectives for the Department's multiple resource assessment and management objectives. Intermittent streams are not sampled at this time due to limited resources (see Program Gaps). Geographic Information

System (GIS) technology will be used to characterize land use, and other measures of factors impacting stream integrity, to proportionally direct greater sampling effort to stream classes where environmental health is at greatest risk.

The basic sampling unit will be assessment reaches within stream classes. These reaches are best described as: 1) small, narrow coldwater; 2) small, wide coldwater; 3) large coldwater; 4) small, narrow warmwater; 5) small, wide warmwater; and 6) large warmwater.

The fiscal and staff support made available for the Baseline Streams Monitoring Program will be dependent upon the various data and data quality objectives needed to address multiple program information needs. A long-term stream monitoring design is currently being developed to identify the number of stream sites to be sampled annually, as well as long-term, to characterize all of the State's stream resources in a timely fashion (Table 3).

Table 3. Number and miles of perennial streams in Wisconsin (1:24K hydrography layer).*

Total Number of Perennial Streams:	**22,613**	**Total Miles of Perennial Streams:**	**41,464**
Number of Streams by Order		**Miles of Streams by Order**	
Stream Order 1	14,744	Stream Order 1	9,530
Stream Order 2	5,313	Stream Order 2	11,346
Stream Order 3	1,858	Stream Order 3	9,388
Stream Order 4	540	Stream Order 4	6,110
Stream Order 5 or more	148	Stream order	5,091

*Note: This analysis does not include intermittent streams.

Core and Supplemental Water Quality Indicators

Physical, chemical, and biological measures will be used singly, or in concert to assess stream health. Certain water quality parameters, such as *E. coli*, ammonia, phosphorus, total suspended solids, and hardness will be monitored at only a subset of stream sites according to the season's sampling design. As resources are available, additional metrics may be added on a case-by-case basis as identified during workplanning. Each parameter is measured only once per site; however, because some parameters must be sampled during different time periods to achieve representative results, sites are usually visited more than once per summer.

Core Indicators for Large Streams (> 2nd Order)

- **Fish Community Characteristics:** Fish indices of biotic integrity (IBIs), developed for Wisconsin's streams, provide valuable measures of stream integrity, productivity, and the quality of sport fisheries. Standard field protocols, designed and calibrated for Wisconsin's cold and warmwater streams, are used for sampling fish communities in streams. This effort consists of daytime electrofishing of a stream assessment reach 35 times the mean stream width, during baseflow conditions in the spring. Fish data collections from this effort are sufficient to compute stream IBI and gamefish population metrics.

- **Gamefish Population Dynamics:** Relative abundance of all fish species sampled in the spring, as well as recruitment, population size-structure, and age and growth of targeted gamefish populations are estimated.

- **Water Chemistry:** In-situ water temperature, dissolved oxygen, pH, conductivity, and turbidity is measured prior to fish sampling or habitat assessment. In addition, a statewide water quality strategy is

currently being developed for select parameters that will be measured with laboratory-analyzed grab samples (see the Surface Water Quality section of the *Strategy*). These data will be assessed periodically to determine trends and to assist in the development of appropriate water quality criteria and in the establishment of proper water quality-based effluent limitations for WPDES permits.

- **Macroinvertebrates:** A subset of large stream reaches will be sampled with Department standard protocols for macroinvertebrate collection. Field staff currently collect one riffle kick sample of macroinvertebrates in the fall for analysis from each stream station. The Department is currently evaluating the rigor of current field and laboratory protocols for macroinvertebrate sampling to improve the quality of information generated by collecting these data.

- **Habitat Assessment:** A fish habitat rating (FHR) index will be used at a subset of large stream sites (~25% of sites) in the spring to assess channel morphology, flow, bank features, fish cover, substrate, and riparian land cover along the fish IBI station.

Core Indicators for Small Streams (1st and 2nd Order)

- **Macroinvertebrate communities:** Sampling of macroinvertebrate communites will continue to be the primary biotic indicator for monitoring all small streams. A number of macroinvertebrate community attributes and biotic indices are used as measures of stream health. Field staff currently collect one riffle kick sample of macroinvertebrates in the fall for analysis from each stream station. The Department is currently evaluating the rigor of current field and laboratory protocols for macroinvertebrate sampling to improve the quality of information generated by collecting these data.

Supplemental indicators for large and small streams

The Streams Subteam may decide that certain sites need to be sampled for additional metrics to meet specific objectives. The following are examples of the most common additional objectives and the supplemental indicators that would be added to address them.

- Nutrient analysis (see Surface Water Quality section)
- Fish Tissue Contamination

Quality Assurance

The WDNR has a quality management plan (QMP) and an Evaluation System Manual Code (MC 9314.1) in place that establish processes and protocols that the state's monitoring program must meet. The QMP is scheduled for review and revision by 6/30/05, and quality assurance processes may be added or modified as needed.

Standard monitoring protocols are distributed to all staff participating in monitoring. Protocols and data sheets are also accessible at any time on our network and web-based database. Training of field staff for consistency in data collection and recording is critical to the success of the monitoring program. Training in taxonomy, deployment of field gear, and general program implementation is periodically made available to all staff. A layer of quality assurance to maximize data integrity through a data screening process is built into the statewide database. All monitoring protocols employed, at a minimum, meet the Department's data standards as developed by the Aquatic and Terrestrial Resources Inventory (ATRI) Team.

Data Management

An internet-based electronic data storage system following state geo-locational standards is used to manage fish and habitat data (http://infotrek.er.usgs.gov/wdnr_bio/). These data are accessible to the public. In 2005-06, the SWMS project (through a potential NEIEN Grant) will facilitate the flow of data from the

USGS server through SWMS to USEPA STORET. Macroinvertebrate data are maintained through a contract with Aquatic Entomology Laboratory, University of Wisconsin, Stevens Point (http://www.uwsp.edu/water/biomonitoring/index3.htm). Contaminant data are managed on a client-server system and are available upon request. Program reviews are conducted every biennium to review progress on completion of monitoring and data entry.

Data Analysis and Assessment

For streams and rivers, rankings for fish community IBI scores have been developed and calibrated for Wisconsin waters. These IBI rankings have been fitted to waters statewide using a scale of 0 – 100, where waters are in poor, fair, good, or excellent ecological condition. Similar rankings for the Hilsenhoff Biotic Index are available to rank macroinvertebrate community condition.

In the near future, as more Baseline Monitoring data is gathered, biotic core indicator rankings will be developed for our more precise stream classes. We will then be able to refine our standards of attainment scale, calibrating stream potential within each class to environmental settings.

In addition, probability-based subsampling of core indicators from all waterbody classes within the geographical scale of interest will allow inferences to be made for all waters within the area on a basin, ecoregional, or statewide scale.

Reporting

Data from Baseline Lakes data are used to develop the integrated 303(d)/305(b) Report. Biennial administrative reports are produced on the work accomplishments of the monitoring program. Local reports on the health and condition of waterbodies and their fisheries are sometimes produced, but more consistent data entry and data proofing will be required to enable a more systematic approach to this reporting.

Programmatic Evaluation

The Baseline Monitoring Program operates within the framework of the Water Division biennial workplan. Each Subteam (i.e., lakes, rivers, streams, etc.) meets annually to review the protocol, strategy, and products of the sampling program to ensure that it is meeting the needs of resource managers. Any changes to the protocol or strategy are recommended to the Water Division Monitoring Team. Reviews of workplan performance are completed annually, to evaluate job completion.

General Support and Infrastructure Planning

Staff & Training – The staff support for streams monitoring will be dependent on the various data and data quality objectives needed to address multiple program information goals. The wadable streams program may be a good match for citizen data collection. Volunteers will be considered to conduct some of the monitoring for this program.
Laboratory resources – Not applicable.
Funding – This program is funded under an EPA 106 grant. During the last two biennia, the 106 amount allocated to streams monitoring has been $210,000 annually, which includes estimated support, including permanent salaries, fringe benefits, and other indirect costs, but does not include FTEs. Starting with the 2005 field season, a portion of 106 funds will be reallocated to water quality sampling; the final amount for this reallocation is yet to be determined.

Program Gaps

- Determine sampling effort on individual streams. A fundamental question that needs to be addressed is how many assessment reaches need to be surveyed per stream to adequately characterize the entire stream thread? Preliminary analyses of fish community (Fish Index of Biotic Integrity) and stream

habitat indices data from Wisconsin streams, suggests that first and second-order streams have relatively high within-stream variability, necessitating sampling more sites per stream to detect desired levels of change. Higher order streams show less inherent within-stream spatial-variability, and as a result fewer assessment sites need to be sampled to adequately characterize the overall condition of larger individual streams.

- An EPA National Wadeable Stream Assessment was received to begin developing reference conditions in 2006. Establishment of reference conditions is important to provide expectations for what healthy streams look like. Reference conditions are the physical, chemical, and biological criteria or "expectations" the Department will use to determine whether aquatic resources are meeting their potential. Data gathered from "least-impacted" streams provide the information necessary to develop reference conditions. It should be recognized that reference conditions (resource expectations) will vary among geographic regions, and stream types.
- The Department is currently evaluating the sensitivity of a small stream fish IBI. Preliminary results suggest that fish communities in small streams are species-poor and dominated by environmentally - tolerant taxa regardless of watershed and overall stream physical condition. These results suggest fish sampling may be useful for some purposes, but indicate other physical or biological measures may be needed to accurately assess the integrity of small streams.
- Studies need to be completed that evaluate whether single habitat (riffle) or multiple-habitat macroinvertebrate samples provide greater discriminatory power when evaluating impaired streams.
- Additional measures of physical habitat quality need to be developed for more accurate assessments of stream habitat quality.
- A multi-metric scale of stream health that combines, physical, chemical, and biological data needs to be developed for Wisconsin streams to provide an overall measure of stream integrity that combines multiple, disparate, measures of stream integrity.
- Intermittant streams are currently not being sampled due to the difficulty in identifying and tracking the large numbers of intermittent streams. Ideally, these would be included in our comprehensive coverage of streams, but with the budget realities this is not possible at this time.

WATER ACTION VOLUNTEER EDUCATIONAL PROGRAM

Author: Kris Stepenuck

Status: Currently in Place

Water Action Volunteers (WAV) is run jointly between WDNR and University of Wisconsin-Extension, in cooperation with local partners. Established in 1997, it is funded through EPA 319 funds and US Department of Agriculture (USDA) Cooperative State Research, Education, and Extension Service (CSREES) 406 funds. WAV is primarily an educational program, but it should be noted that WDNR is creating a parallel strategy to utilize those volunteers who wish to do more rigorous data collection in accordance with WDNR protocols (see draft proposal in Appendix A). These quality-controlled data would then be pooled with other WDNR data for use in management decision making.

Monitoring Objectives

WAV is a primarily educational program that helps to assess the chemical, physical, and biological quality of selected wadable Wisconsin streams and rivers statewide.

Clean Water Act Objectives

This program is primarily educational.

Specific Objectives

- Give Wisconsin citizens the opportunity to monitor stream and river health.
- Support data sharing for educational purposes.
- Provide a network for volunteer monitoring groups, individuals, and schools to interact.
- Provide support for civic conservation and environmental groups to conduct stream monitoring.
- Increase linkages between volunteer monitoring efforts and public resource protection programs.

Monitoring Design

Nearly 200 adults and 600 students in 26 locally operated programs currently monitor monthly at about 135 streams (at nearly 200 sites) statewide on a seasonal basis (April-October) through the WAV Program. Water quality monitoring locations for this program are determined locally. In some instances volunteers are directed to sites to monitor by local DNR or County biologists, while in other cases, volunteers are allowed to choose their monitoring location based on interest/accessibility.

Volunteers are requested to monitor each site once a month for turbidity, temperature, stream flow, and dissolved oxygen from April through October. Habitat is monitored annually in late spring or summer, and biotic index is monitored twice a year, in the spring and in the early fall (late September/early October).

In addition, a subset of WAV, called the Trained Local Sampler Program (TLS), operates in conjunction with the Discovery Farms Program. TLS monitoring is more intensive than WAV monitoring, with volunteers monitoring every other week to once a month throughout the year for turbidity, temperature, dissolved oxygen, nitrates, ammonia, alkalinity, conductivity and pH. Seasonally, they collect grab samples and ship them to a certified lab for nutrient (total phosphorus, Total Kjeldahl Nitrogen, chloride, Nitrite + Nitrate as N, ammonia) and total suspended solids analysis.

Core and Supplemental Water Quality Indicators

- Turbidity (using a turbidity tube calibrated to inches and then converted to nephelometric turbidity units (NTUs) using an empirically derived calibration),
- Temperature (using a hand-held thermometer)
- Stream flow (by measure average depth across a transect, width across the transect, and surface velocity)
- Dissolved oxygen (using a Hach dissolved oxygen test kit, Model OX-2P)
- Habitat (using a subjective 10 question data recording form based on EPA volunteer stream monitoring methods (EPA 841-B-97-003))
- Biotic index (a modified Hilsenhoff Biotic Index in which organisms are identified to order)
- Various field observations
- New in 2004, volunteer monitors who are interested will be trained to collect and identify rusty crayfish, an invasive species to Wisconsin.

Quality Assurance

Although there is no QAPP or written quality assurance procedure for WAV monitoring, several quality components are in place. Annual training is done for new and interested returning volunteers, using standard methods and data sheets provided in the Volunteer Monitoring Fact Sheet Series. The Fact Sheet Series is also available on the web at http://clean-water.uwex.edu/wav/monitoring/factsheet.htm (fact sheets) and http://clean-water.uwex.edu/wav/monitoring/datasheet.htm (data sheets). A video of monitoring methods is currently under development, which volunteers will be able to use to refresh their training before each season. There are approximately 35 trained local coordinators for WAV programs, some of whom conduct follow-up field visits after the training sessions. These coordinators enter all data into the WAV database to ensure its consistency and validity.

Data Management

All field-collected data are entered by trained local data entry coordinators into the WAV database, an online Oracle database managed at the University of Wisconsin-Extension. Each data processing step is accompanied by a QA/QC check to ensure accuracy. All data are verified from original field sheets and data printouts. Corrections are made, checked and the procedure repeated until an error-free copy is obtained. Additional data quality checks are made by the WAV Coordinator during data analyses. All chemical, biological, and physical data from the WAV program are considered public information and are available through the WAV Database online at: http://clean-water.uwex.edu/wav/datagate.htm. At this site, metadata are included that indicate methods followed for data collection, the range of scores able to be determined with WAV methodology, and a description of local programs, including their program goals and a general description of their volunteers. Discovery Farm TLS data are available at: http://www.uwex.edu/ces/erc/discovery/.

It is expected that data from the WAV database will be migrated to the WDNR's SWMS datasystem in 2005. All WAV monitoring sites can obtain stations from the SWMS station application module so that this data can be integrated with other ecological data in mapping applications. Stream monitoring stations are documented by Hydrologic Unit Code (USGS), the Department's unique Waterbody Identification Code (WBIC), County, and site descriptions. Latitude/longitude coordinates have been recorded for about 1/3 of the nearly 200 registered sites to date, with plans for all sites to have latitude and longitude entered in accordance with the policy established by the Department by the end of 2004.

Data Analysis/Assessment

To date, the data collected through the WAV program have primarily been used educationally and locally by citizens involved in the program. In a few instances (i.e., Pigeon River WAV Program, and Nohr Network of Monitors), data collected by volunteers have been used in Basin reports.

Reporting

Data are summarized to be meaningful to the volunteers who collect them. The WAV program routinely provides water monitoring data summaries in the form of monitoring brochures to the general public and these are available online at: http://clean-water.uwex.edu/wav/datagate.htm. To date (the database began being populated in 2002), not all sites that have been monitored have data summary brochures created. Occasionally, WAV data are used in Basin reports as well.

Programmatic Evaluation

The WAV program recently undertook two major programmatic evaluations. In the Spring of 2003, a survey of volunteers was conducted to assess the level of learning and of networking improvements experienced by WAV participants. In the Spring of 2004, an evaluation of the WAV database was completed. In addition, evaluation surveys are collected after each annual training session, and modifications are made to the program as appropriate.

General Support and Infrastructure Planning

Staff & Training – One half-time FTE is allocated to this program, funded jointly by WDNR and University of Wisconsin-Extension (UWEX). Approximately 35 local coordinators are funded through other sources such as grants, or volunteer their time.
Laboratory resources – No laboratory analysis is required.
Funding – Funding is provided through 319 funds and USDA CSREES 406 funds. Initial set-up of each new site costs $200 in equipment needs. Other expenses include publications and travel.

References

Wisconsin Dept. of Natural Resources and University of Wisconsin-Extension. Volunteer Monitoring Fact Sheet Series, DNR Pub WT-755, UWEX Pub GWQ026. Fall 2001.

WETLANDS

Author: Tom Bernthal

Status: Proposed

This program is currently under development and consists largely of pilot projects at this time. Current funding from the EPA Wetland Program Development Grants program (averaging about $200,000 per year) covers the salary for one statewide coordinator position and 2.5 LTE positions per year through September 2006. These positions support several pilot projects that will likely serve as models for the design and implementation of an ongoing baseline and project monitoring program. Implementation will require a reliable source of federal funding and a state commitment to continue to direct resources to a wetland assessment and monitoring program.

Monitoring Objectives

Clean Water Act Objectives

- Establishing, reviewing and revising water quality standards
- Determining water quality standards attainment
- Identifying impaired waters
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific objectives

Assessment methodologies that are being developed for wetlands vary in focus from extensive, mapping exercises to support planning for wetland protection, acquisition and restoration to site-specific surveys used to determine wetland condition and the cause and extent of problems. Four major objectives are currently being pursued.

- Characterize wetland function and condition at the watershed scale for planning purposes
- Identify wetland restoration opportunities (potentially restorable wetlands)
- Track wetland conservation activities and permitted wetland impacts at the watershed level
- Monitor the impact of specific wetland management projects (compensatory mitigation projects, selected restoration projects)

Monitoring Design

Design will incorporate the "three tier framework" endorsed by the USEPA National Wetland Monitoring Workgroup to efficiently gather scientifically valid information that meets the needs of managers. Level 1, landscape assessment, relies on coarse, landscape scale inventory data typically gathered by remote sensing and available in a GIS format, such as the Digital Wisconsin Wetland Inventory. Level 2, rapid assessment, consists of relatively simple rapid protocols to be conducted at specific sites. Level 3, intensive site assessment, uses intensive ecological measures to score the relative condition of a site, based on research-derived indices of biological integrity. Due to likely funding limitations and the need to tie wetlands assessment to watershed planning, Department management structure, and restoration opportunities, it is recommended that implementation of a formal wetland monitoring program be conducted on a rotating

basin basis; with assessment at the basin scale. The number of sites needed for representative coverage and sampling frequency for future level 2 and 3 assessments is still to be decided.

Extensive landscape level assessment using available GIS wetland inventory, hydrography soils and land-use/land cover data for coarse assessment, supplemented by follow-up rapid and intensive site assessments, is contemplated at the Basin (equivalent to 8 digit hydrologic units (HU)) scale. The initial focus will be to identify wetland restoration opportunities and characterize wetland condition at the watershed (10 digit HU) and subwatershed (12 digit HU) level. Monitoring design will be guided by the lessons learned in current pilot projects in the Milwaukee River Basin and in the Mead Lake watershed. Implementation will depend upon continued federal and state funding.

Core Indicators

- Occurrence and abundance of reed canary grass (*Phalaris arundinacea*) monotypic areas – 30m resolution, ½ acre minimum mapping unit; occurrence of other wetland invasives such as purple loosestrife (*Lythrum salicaria*) and giant reed grass (*Phragmites australis*) to characterize condition of the plant community
- Floristic Quality Assessment (FQA) scores: Floristic Quality Index (FQI) and Average Conservatism (mean C) for intensive (Level 3) site surveys to characterize condition of the plant community
- Indices of Biological Integrity (IBIs) for isolated depressional wetlands, based on plants, macroinvertebrates, zooplankton, diatoms, and amphibians have been developed for intensive (Level 3) site surveys to characterize biological condition

Quality Assurance

Quality Assurance Project Plans are completed for each grant project where environmental data are gathered.

Data Management

A statewide database of wetland project activities is currently under development with site descriptions and/or latitude/longitude. Current plans call for tracking restoration and conservation projects, compensatory mitigation projects, and permitted losses in a unified tracking database. The target for completing the database design and pilot data collection is September 2005, with implementation to begin thereafter, depending on grant funding. There are no immediate plans to make the data available via the World Wide Web.

Mapping of reed canary grass monotype areas across the entire state will begin in 2005 and is expected to be complete by September 2007. The resulting GIS coverage will be incorporated in the Department's GIS library and a graphic representation will be put on the Department's Wetlands Assessment and Monitoring web page http://dnr.wi.gov/org/water/fhp/wetlands/assessment.shtml. The page now contains published reports to EPA on currently available assessment methodologies, results of a pilot project to map reed canary grass monotype wetlands, and links to other related wetland monitoring programs.

Data Analysis/Assessment

The following is a description of the type of data analysis being carried out in pilot programs, which would likely be employed in an ongoing rotating Basin approach to wetland assessment.

In the watershed planning context existing GIS data are used to identify two categories: degraded existing wetlands (wetlands in need of rehabilitation) and converted but potentially restorable areas, and prioritize them for further study and for restoration. Coarse GIS data on potentially restorable wetlands and reed canary grass monotypes will allow a characterization of the level of impairment of wetlands within watersheds. Further site specific study of a subset of existing wetlands and potential restoration sites identified in the coarse screening will need to employ methods that are now under development in Milwaukee River Basin pilot assessment project. Once assessment protocols are in standardized and in place, this data can be stored in the state's Waterbody Assessment Display and Reporting System (WADRs). The manner in

which data on wetland impairment is reported needs to be carefully considered, due to the potential for confusing wetland condition with the assessment of wetland functional values that is sometimes required for regulatory decision-making.

Reporting

Data may be reported in WDNR Basin Plans and the integrated 303(d)/305(b) Report to EPA.

Programmatic Evaluation

Currently annual meetings with regional and national EPA wetland program staff are being held to guide the Milwaukee River Basin Assessment project. Other grant-funded projects include biannual project reports. A formal program evaluation would likely be held in the future when a formal program is implemented.

General Support and Infrastructure Planning

Support for work to date is provided through EPA Wetland Program Development Grants (CWA s.104) with a 25% state match. Averaging about $200,000 per year, this grant covers the salary for one statewide coordinator position and 2.5 LTE positions per year through September 2005. These positions are very likely to be funded through September 2007, supporting several pilot projects that will likely serve as models for the design and implementation of an ongoing baseline and project monitoring program. We expect to learn much about data needs and staffing levels from these pilot projects to apply toward future analysis of infrastructure needs, program design and mobilization costs. Implementation will require a reliable source of federal funding and a state commitment to continue to direct resources to a wetland assessment and monitoring program. Wetland monitoring might provide a very good opportunity for citizen collected data. Once wetland monitoring is established, volunteers will be considered to conduct some of the monitoring for this program.

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Wisconsin Department of Natural Resources Wetland Assessment and Monitoring web-page: http://dnr.wi.gov/org/water/fhp/wetlands/assessment.shtml.

WDNR Wetland Team. 2000. Reversing the loss: a strategy for protecting and restoring wetlands in Wisconsin. Wisconsin Department of Natural Resources publication FH-232 2000.

GREAT LAKES

In addition to the monitoring programs described below, Lakes Superior and Michigan have 15 public water intakes that are monitored according to the Safe Drinking Water Act, using the same protocols as described in the Public Drinking Water Well Monitoring section in Tier 3.

The *Joint Strategic Plan for Management of Great Lakes Fisheries* provides the institutional framework for inter-jurisdictional cooperation in data collection related to fisheries management. As a signatory to the Joint Strategic Plan the Department is committed to the "Management Information Strategy": *The parties must exercise their full authority and influence in every available arena to meet the biological, chemical, and physical needs of desired fish communities.*

LAKE MICHIGAN MAJOR TRIBUTARY PHOSPHORUS LOADING

Authors: Shaili Pfeiffer, Jim Baumann

Status: Proposed-Some Infrastructure in Place

Some of the sampling for this program can be done at current Long Term Trend fixed sites; however, frequency of sampling would need to be increased. Funds for data analysis will also be needed.

Monitoring Objectives

Clean Water Act Objectives

- Determining water quality standards attainment
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific objectives

The primary objective for monitoring phosphorus loads in major Lake Michigan tributaries is to develop long term trends for phosphorus loading to Lake Michigan, providing early warning of rising trends, and information for management issues that arise. This monitoring component is intended to be a supplement to the existing ongoing trend monitoring.

Monitoring Design

Monitoring will focus on selected tributaries representative of the largest drainage area, largest sources of phosphorus and streambed sediment type. Sampling locations will coincide with permanent USGS stream gauging stations. Three to four tributaries addressing these criteria in order of importance are: 1) Fox River, 2) Milwaukee River, 3) Manitowoc River, and 4) Menominee River. The same sites would be sampled annually, using a flow proportional sampling protocol based on 25 samples/year. This entails sampling during storm events rather than on a regular monthly schedule as is currently being done at the Long Term Trend sites.

Core and Supplemental Water Quality Indicators

The core indicator is total phosphorus, typically the limiting nutrient that affects aquatic plant growth and recreational water uses. Total suspended solids may also be included as an indicator.

Quality Assurance

Quality Assurance procedures should follow standard DNR or USGS protocols. If monitoring is contracted with USGS, USGS will need to produce QAPP.

Data Management

Water quality data from this monitoring component will be stored in the SWMS system and will also flow to the USEPA STORET. These data are readily available internally through the intranet. All monitoring sites will be geolocated.

Data Analysis/Assessment

Critical to this monitoring is annual analysis of phosphorus loading to the Lake Michigan. Some of the data required for the assessment of the Milwaukee River and Fox River may already be collected by other sources, Milwaukee Metropolitan Sewage District and UW Green Bay, respectively. A key aspect of the monitoring program is for an annual load analysis to be conducted perhaps by contract to the USGS.

Reporting

Great Lakes nearshore data would be used for assessments required by Section 305(b) of the CWA. The Great Lakes Chronicles published by the Wisconsin Coastal Management Program is another possible opportunity for reporting. Additional reporting opportunities may arise as through other regular "State of the Lakes" publications.

Programmatic Evaluation

It has not yet been determined what level of sampling would most efficiently provide the needed information. As the program progresses, modifications can be made as needed.

General Support and Infrastructure Planning

We propose that the sampling and analysis be contracted from the USGS. Laboratory analysis costs are estimated at $1,600 - $3,700. Estimated costs for a contract with USGS for sample collection and analysis are $15,000. If WDNR decides to do analysis internally (for instance, using Coastal Management funds), load calculations will take the bulk of the staff time involved. Volunteers may be considered to conduct some of the monitoring for this program.

FISHERIES ASSESSMENTS

Authors: Tim Simonson, Bill Horns

Assessments of Great Lakes fisheries are used to guide management actions. The primary means of assessment are angler creel surveys; trawl and gill net surveys; statistical catch-at-age modeling of yellow perch in Green Bay and Lake Michigan, lake trout in Lake Superior, and lake whitefish in Lake Michigan; and monitoring of salmon and trout spawning runs. Lake-wide inter-jurisdictional data sharing is accomplished through the Lake Committees and Lake Technical Committees. The Lake Michigan program is described in the Lake Michigan Integrated Fisheries Management Plan, 2003-2013.

Status: Currently in Place

This program in its present form was established in approximately 1980 and has been consistently implemented using a variety of funding sources.

Monitoring Objectives

Clean Water Act Objectives

- Identifying impaired waters
- Supporting the evaluation of program effectiveness

Specific Objectives

- Determine trends in the population status and health of major sport and commercial fisheries
- Evaluate program effectiveness
- Develop management plans

Monitoring Design

- Annual stratified random angler-contact creel surveys
- Statistical catch-at-age modeling of yellow perch in Green Bay and Lake Michigan, lake trout in Lake Superior, and lake whitefish in Lake Michigan using data collected by trawl, gillnet, seine, creel survey, commercial catch reports, and dockside monitoring of commercial catches
- Monitoring of salmon and trout spawning runs at three spawning weirs
- Lake-wide, multi-agency data sharing regarding species of common interest, including chinook salmon and lake trout
- Lake-wide surveys of forage species (primarily by USGS Great Lakes Science Center, but with cooperation by states)
- Estimates of trends in sea lamprey abundance by the Great Lakes Fisheries Commission (GLFC)
- Fish health inspections conducted at spawning weirs
- Local surveys to assess smallmouth bass and walleye
- Mandatory annual commercial harvest reporting
- Gill net assessments of bloater chubs
- Gill net assessments of lake trout
- Special, targeted studies

Core and Supplemental Water Quality Indicators

- Angler effort, catch, and harvest
- Population abundance
- Fish health and condition
- Length frequency
- Age and growth
- Diet
- Recruitment

Quality Assurance

Standardized protocols are used and training is provided. Data sharing and assessment coordination through the Lake Michigan and Lake Superior Committees provides a mechanism for inter-jurisdictional scrutiny of our data and analyses.

Data Management

Data are maintained in Great Lakes databases available on the internet at http://dnr.wi.gov/org/water/fhp/fish/lakemich/.

Data Analysis/Assessment

Data from Great Lakes surveys are used to guide the propagation and stocking of salmon and trout, establishment and revision of sport and commercial fishing regulations, and establishment of fishing harvest limits. Data are shared with other jurisdictions through the Lake Michigan Committee and Lake Superior Committee.

Reporting

Data are reported in the following manners:

- State Fish Restoration (SFR) or Fish-SEG Progress Report
- Annual Lake Michigan Management Report to the Lake Michigan Committee
- Annual Lake Superior Management Report to the Lake Superior Committee
- Biennial Great Lakes Salmon & Trout Stamp Revenue Expenditures Report
- Annual reports on returns of fish to spawning weirs
- Annual creel survey results
- Annual fish stocking reports

Programmatic Evaluation

Program review is accomplished with regular meeting of the Lake Michigan Fisheries Team, the Lake Michigan and Lake Superior Committees, and the Lake Michigan and Lake Superior Technical Committees.

General Support and Infrastructure Planning

Staff & Training – Approximately 20 FTE participate in this monitoring activity. Volunteer participation in these activities is problematic in almost all cases because of the training and technical skills required.
Laboratory Resources - None.
Funding - Funding for this activity comes from the segregated account (Fish) and Great Lakes Trout and Salmon Stamp sales.

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PATHOGEN MONITORING ON GREAT LAKES BEACHES

Author: Toni Glymph

Status: Currently in Place; Temporarily Funded

This program was established in 2002 and is currently being funded under the Beaches Environmental Assessment and Coastal Health (BEACH) Act grant. The grant is guaranteed through the 2005 beach season.

Monitoring Objectives

The Beaches Environmental Assessment and Coastal Health (BEACH) Act, passed in October of 2000, authorized EPA to provide grants to States that have beaches bordering coastal or Great Lakes recreational waters for the purpose of developing a beach monitoring and public notification program. This effort is directed at Great Lakes coastal waters, namely Lake Michigan and Lake Superior. The purpose of this program is to monitor beaches along the Great Lakes in accordance with BEACH Act requirements, allow for prompt notification to the public whenever bacterial levels exceeds EPA's established standards, and investigate alternative methods for public notification. This information will be used to investigate long-term trends in water quality and to establish a beach monitoring and public notification plan that will assist communities along the lake shore to improve their ability to monitor and notify beach users of risks associated with high bacteria levels.

Clean Water Act objectives

- Monitoring and assessing coastal recreation waters to determine attainment of applicable water quality standards for pathogen indicators. (CWA section 304(a), Section 305(b))
- Prompt notification of the public of any exceedances or likelihood of exceedances of water quality standards for pathogen indicators. (CWA section 406)
- Establishing, reviewing, and revising water quality standards (CWA Section 303(c)).

Specific objectives

- Strengthening water quality standards for bathing beaches
- Improving state and local beach programs
- Providing better information regarding beach water quality to the public
- Promoting scientific research to better protect the health of beach users.

Monitoring Design

The Wisconsin Beach Monitoring Program was developed in accordance with EPA performance criteria. Adherence to the program performance criteria is required for all participants in the Wisconsin Beach Monitoring Program.

Lake Michigan and Lake Superior are coastal recreational waters designated in Wisconsin Administrative Code, Chapter NR 104 for swimming, recreational bathing and other contact water activities. Only beaches located along the Lake Michigan and Lake Superior shorelines were identified and evaluated. For the purpose of the BEACH Act, beach shall be defined as:

> "A publicly owned shoreline or land area, not contained in a man-made structure, located on the shore of Lake Michigan or Lake Superior, that is used for swimming, recreational bathing or other water contact recreational activity."

173 public beaches along Lakes Michigan and Superior have been identified, and located via the use of global positioning system (GPS) and GIS technologies. A map identifying each beach was developed indicating the adjacent coastal recreation waters, beach location and any known potential sources of pollution. Each beach was evaluated to identify the potential risk of disease to swimmers and to classify the beaches accordingly.

Beach waters that have a high potential for fecal contamination and/or have high usage are considered high priority. All beaches were evaluated using a standard evaluation form and classified as either High, Medium or Low priority based on the following factors:

- The nature and extent of the use
- The proximity to known point and non-point sources
- Any effects of storm events on the waters.

A tiered monitoring plan describing the monitoring requirements for *High*, *Medium* and *Low* priority beaches was developed. It addresses when basic sampling should be conducted, when additional samples should be collected and where and how to collect samples.

Table 4. Sampling design for high-priority Great Lakes beaches.

Basic Sampling	***Additional Sampling***	***Where to Sample***	***Depth to Sample***
• Begin sampling at least one week prior to the swimming season • Sample at least ***5 times*** per week during the swimming season	• After heavy rainfall (generally ¼ to ½ inch-depending on local conditions) • After a major pollution event where potential exists that indicator levels may be expected to exceed standard (sewage leak, spill) • Immediately following the exceedence of the water quality standards	*Depends on characteristics of your beach* • Middle of typical bathing area • For longer beaches, one sample for every 500m of beach	• Knee depth • Where 24-30 inch depth is first encountered, take sample 6-12 inches below surface of water • Other as you feel is necessary for your beach *(e.g., surface of water, waist depth, sediment)*

Table 5. Sampling design for medium-priority Great Lakes beaches.

Basic Sampling	***Additional Sampling***	***Where to Sample***	***Depth to Sample***
• Begin sampling at least one week prior to the swimming season • Sample at least ***2 times*** per week during the swimming season	• After heavy rainfall (generally ¼ to ½ inch-depending on local conditions) • After a major pollution event where potential exists that indicator levels may be expected to exceed standard (sewage leak, spill) • Immediately following the exceedence of the water quality standards	*Depends on characteristics of your beach* • Middle of typical bathing area • For longer beaches, one sample for every 500m of beach	• Knee depth • Where 24-30 inch depth is first encountered, take sample 6-12 inches below surface of water

Table 6. Sampling design for low-priority Great Lakes beaches.

Basic Sampling	***Additional Sampling***	***Where to Sample***	***Depth to Sample***
• Begin sampling at least one week prior to the swimming season • Sampling frequency at low priority beaches should be determined by state and local authorities, taking into account resource constraints and evaluation of risk factors at individual beaches.	• After a major pollution event where potential exists that indicator levels may be expected to exceed standard (sewage leak, spill) • Immediately following the exceedance of the water quality standards	*Depends on characteristics of your beach* • Middle of typical bathing area	• Knee depth • Where 24-30 inch depth is first encountered, take sample 6-12 inches below surface of water

Core and Supplemental Water Quality Indicators

The "Advisory" standard of 235 CFU/100mL *(E. coli* in water) was adopted for the beach program as a requirement of the BEACH Act and based upon data from three US EPA studies conducted in the late 1970s. These studies indicate that *E. coli* and/or Enterococci are the best bacterial indicators to assess the risk of acquiring a gastrointestinal illness as a result of using recreational waters. These levels are the original recommendation of US EPA and they were reaffirmed in a revisiting of the issue in 2002. Additional epidemiological studies are set to take place during the BEACH program and should be completed by 2008.

The epidemiological studies indicated that a level of 235 CFU of *E.coli*/100mL of recreational water is approximately equal to 8 cases of gastrointestinal illness per 1000 recreational water users. The "Closure" level of 1000 CFU *E.coli*/100mL was adopted by the WI DNR based upon data from the studies mentioned above and represent a risk of approximately 14 cases of gastrointestinal illness per 1000 recreational water users.

EPA recommends the following criteria for *E. coli*:

- 235 cfu/100mL as a single sample maximum
- 126 cfu/100mL as a geometric mean of at least 5 samples collected over a 30-day period.

Quality Assurance

A number of quality control checks are required to ensure the quality of the data generated. All laboratory staff will adhere to current and generally accepted practices for safe handling, testing of samples, and chain of custody measures.

Precision

Precision of sampling methods will be estimated by taking two samples at the same sampling site at approximately 10 percent of the sites. The precision of laboratory analyses is estimated by analyzing two or more aliquots of the same water sample. This data quality indicator is obtained from two duplicate samples by calculating the relative percent difference (RPD) as follows:

$$RPD = \frac{|C_1 - C_2|}{(C_1 - C_2)/2} \times 100$$

Where C_1 is the first of the two values and C_2 is the second value. Because of the heterogeneity of populations of bacteria in surface waters, an RPD of less than or equal to 50 percent between field duplicates for microbiological analyses might be considered acceptable. Analysts should be able to duplicate bacterial colony counts on the same membrane within 5 percent and the counts of other analysts within 10 percent; otherwise, procedures should be reviewed and corrective action implemented.

Accuracy
Because accuracy is the measurement of a parameter and comparison to a "truth" and the true values of environmental physicochemical and biological characteristic cannot be known, use of a surrogate is required. To estimate the densities of bacteria, use of samples prepared from known quantities of freeze-dried and cultured bacteria as a surrogate can result in 97.9 percent recovery of the bacteria from water samples. Based on the mTEC medium, bias was determined to be 2 percent of the true value. This information is helpful in establishing the most appropriate methods to be followed.
Representativeness
In the sample design, care is taken to determine if the area of sample collection is typical and representative of each area of concern. For lengthy beaches, if bathers are relatively evenly distributed along the beach area, samples will be spaced a maximum of 500 meters apart. For beaches where bathers are concentrated in one area, 1 sample will be taken where most of the swimmers congregate and then a sample shall be taken 15 meters on either side.

Data Management

The United States Geological Survey (USGS), in partnership with the City of Milwaukee Health Department, City of Racine Health Department, and the University of Wisconsin-Milwaukee Great Lakes WATER Institute developed the "Beach Health" website. This website is used as a tool to post real-time information about beach water quality at beaches in Milwaukee, Kenosha and Racine.

The Wisconsin Beach program expanded the current "Beach Health" website to include all the Great Lakes beaches that are monitored through this program. The website contains beach water quality data and real-time advisories for the general public as well as real-time environmental data for use by the scientific community. The site also contains links to pollution prevention information and project partners, as well as general pollution prevention information. Designed and maintained by the United States Geological Survey (USGS), the website delivers beach water quality and information from early May through September. All data collected from beaches along Lake Michigan and Lake Superior are stored in a database and can be queried by the public. The availability of the data and the website capabilities allow health professionals to share information used in assessing risk to the public and understanding trends in water quality, and enhancing regional pollution prevention efforts. The Beach Health website also includes links to local health department websites.

At all levels of government, the data will be collected by beach managers and/or designated "data stewards". Participating levels of government include municipalities, counties, and administrators of state properties such as the State Parks. The "data stewards" are responsible for coordinating the collection of monitoring data at all the beaches in their jurisdiction. The monitoring data is entered into an Oracle database housed at the U.S. Geological Survey in Middleton, Wisconsin. Data stewards or lab personnel enter results of monitoring data into password-protected online web forms.

Daily notification data comprised of the types of notification that are given for beaches on a daily basis (i.e., good or poor water quality conditions or open/closed beaches) is entered into the Oracle database using password-protected online webforms. The notification data is also stored in the Oracle database. Notification information is available to the general public on the website as soon as an advisory is posted (www.wibeaches.us). Reports of historical data are also available on the website.

BEACH data relevant to water quality standards work will be migrated to SWMS in 2005-06.

Data Analysis/Assessment

To assure consistency in collecting samples for analysis, a standard sampling protocol was used for all Great Lakes beaches. Specific sites were designated for collecting samples during the bathing season. Samples were collected exclusively at these sites for the duration of the sampling period. Sample records, chain of custody records, and sample tracking records are reviewed to verify that all the samples collected were analyzed so the data set is complete. Data entries and analyses are also verified. Calculations are reviewed by rechecking the

computations, reviewing the assumptions used and checking the input data against the original sources to be sure transcription errors have not occurred.

Analytical tests are performed by state certified labs. Data is reviewed by DNR staff to determine whether the established QC procedures are being used and how the program is operating. This Project identified specific assessment methods and procedures for collection, preservation, and storage of water samples.

Reporting

At the end of each beach season, notification data is submitted to USEPA in XML form. XML form is a file format that identifies each bit of data with "tags" like the tags HTML uses to make some text bold, make other text red, etc. The USEPA has defined tags for the beach notification data. Data must be submitted in XML format so USEPA can load the data into its PRAWN database.

CDX is the Central Data exchange, which is a USEPA office that provides a single point of entry for incoming data into USEPA. Each state has to first register at the CDX website and then can start submitting data. Users can use CDX or email files to USEPA.

A data report will be submitted to the US EPA at the end of the beach season, by the end of September. Local governments will submit status reports to the WDNR throughout the beach season on a monthly basis. The State Coordinator will be responsible for submitting a final report to EPA at the end of each beach season.

Programmatic Evaluation

The effectiveness of the monitoring program is assessed annually through the use of surveys, annual meetings with beach program participants and performance evaluations.

General Support and Infrastructure Planning

Currently, approximately $350,000 is required to fully implement the Great Lakes beach monitoring program. BEACH Act funding made available for Great Lakes beaches averaged $225,000 each year and is only guaranteed through 2005. This amount falls short by $125,000 each year. If the grant allocations from EPA remain the same for the 2005 beach season, money will not be available for a LTE to assist in the coordination of the program. Management and assessment of this program requires the work of, at a minimum, one full time employee. If the program continues beyond 2005, consideration must be given to employing a full-time staff or LTE to manage the beach program.

Some local groups are currently submitting beach pathogen data. For future monitoring, WDNR would like to develop a program for collection of data by local public health officials and volunteer groups, following WDNR methodologies.

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MISSISSIPPI RIVER

Author: John Sullivan

Status: Currently in Place

Wisconsin's Mississippi River reach runs 230 miles from the confluence of the St. Croix to the Illinois Border and includes a diverse array of aquatic and terrestrial habitat within this corridor. Eighty percent of this reach (182 miles) is part of the Upper Mississippi River National Wildlife and Fish Refuge, which runs from the Chippewa River mouth to Rock Island, Illinois. The U.S. Corps of Engineers maintains a 9-ft navigation channel and operates 10 locks and dams to facilitate commercial and recreational navigation traffic through Wisconsin's reach. In 1986, Congress recognized the Upper Mississippi River System (UMRS) "as a nationally significant ecosystem and a nationally significant navigation system" (Public Law 99-662). Wisconsin shares its water resource management responsibilities on the Mississippi River with adjoining states (Iowa and Minnesota) and federal agencies and participates in numerous interagency work groups, committees and associations. The Department carries out water quality, fisheries and wildlife management program functions on the Mississippi River through the operation of the Mississippi River Team at La Crosse, Wisconsin (WDNR 1992).

Wisconsin conducts water quality monitoring on the Mississippi River with state-funded programs and federal funding as part of the federal Environmental Management Program (EMP) Long Term Resource Monitoring Program (LTRMP) through the operation of a field station at Onalaska, Wisconsin. EMP is a federal-state partnership authorized by Congress in 1986 to restore, protect and monitor the UMRS to ensure its attainment of its many uses. The first three field stations began monitoring in 1988, followed by the completion of the remaining three stations by 1991. All six stations are currently in operation.

Monitoring Objectives

Clean Water Act Objectives

- Establishing, reviewing and revising water quality standards
- Determining water quality standards attainment
- Identifying impaired waters
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific objectives

Primary water monitoring objectives for the Mississippi River include:

- Collect vital water quality and aquatic biologic data to assess the river's quality and determine long term trends.
- Develop and utilize essential ecological indicators to assess the health of the Mississippi River.
- Coordinate monitoring efforts with other state, federal or local environmental agencies.
- Support and facilitate data and information sharing between agencies and the public.
- Provide water resource information to support management activities.

Wisconsin's Mississippi River monitoring effort can be grouped into basically three categories, roughly corresponding to the three Tiers of this *Strategy*: condition monitoring, problem assessment, and evaluation monitoring. Each of these categories has specific objectives that have been previously identified based on past program guidance (WDNR 1992) and are still relevant today. These categories and monitoring objectives are described below.

Condition monitoring includes those activities that characterize the river's condition, uses and trends and identify where there are problems. Key objectives of this work include:

- Evaluate the general water quality conditions, problems and trends through the adoption of an effective water quality monitoring program.
- Determine use classifications and evaluate use support attainment.
- Complete Clean Water Act reporting requirements as defined by Sections 305(b) and 303(d).

Problem Assessment Monitoring includes specific monitoring tasks to identify the causes, sources and extent of surface water quality problems. Key objectives of this work include:

- Assess surface water impacts of point source discharges including the evaluation of receiving water characteristics (mixing zone evaluations) to develop appropriate effluent limitations to achieve water quality standards.
- Evaluate the impacts of nonpoint source pollution on the Mississippi River or its backwaters.
- Identify water quality related-problems and management activities to support and advance habitat improvement projects on the River.
- Evaluate sediment quality conditions and identify contaminated sediment problems on the River.
- Collection of fish and other tissue samples for the consumption advisory program.
- Conduct monitoring evaluations associated with the issuance of Water Quality Certifications (federal dredging activities) and other regulatory actions not specifically linked to WPDES permits.
- Conduct investigations associated with spills, kills, animal wastes and other complaints.

Evaluation Monitoring includes all monitoring activities associated with evaluating the effectiveness of management actions to meet the goal of maintaining water quality standards, beneficial uses and habitat improvement objectives. Key objectives of this work include:

- Conduct compliance monitoring evaluations of WPDES permits and receiving water quality changes associated with point source pollution abatement activities.
- Evaluate the success of nonpoint source pollution control strategies designed to reduce impairments on the River.
- Evaluate compliance imposed by Water Quality Certifications for federal dredging projects on the River.
- Conduct post-project evaluations of habitat improvement projects to determine if project goals and objectives have been achieved.
- Evaluate the effectiveness of sediment remediation activities for the management of inplace pollutants.

Monitoring Design

Mississippi River water quality monitoring is established through the development of work plans as directed by the Water Division. State-sponsored water quality monitoring work efforts are coordinated by the Mississippi River Water Quality Specialist in La Crosse following general program guidance prepared by the Watershed and Fisheries Management & Habitat Protection Bureaus. Monitoring efforts conducted by the LTRMP follow operational plans, cooperative agreements and scopes of work prepared by USGS with input from federal-state partners (EMP Coordinating Committee and LTRMP Analysis Team) (USFWS, 1992).

State-sponsored monitoring activities on the Mississippi River have primarily focused on fixed station, intensive, synoptic and screening-level sampling designs. LTRMP utilizes a probabilistic sampling design (stratified random sampling) as part of its monitoring in Pool 8 (also Pool 4 by MDNR). Wisconsin expects to increase use of probabilistic sampling designs in the future after further evaluations of the LTRMP effort and the Great River Ecosystem Environmental Monitoring and Assessment Program (EMAP) effort planned for 2004-05. Wisconsin's Field Station at La Crosse (collocated with USGS's Upper Midwest Environmental Sciences Center) is expected to participate with this monitoring effort.

Examples of specific implementation activities include:

- Wisconsin's Long Term Trend (LTT) program monitoring at Locks and Dams 3 (Red Wing, MN), 4 (Alma, WI), 8 (Genoa, WI) and 9 (Lynxville, WI). Site-specific variables include general chemistry, field measurements (DO, temperature, pH conductance, and turbidity), low-level metals, light penetration and contaminant analysis of time-integrated composite suspended sediment samples. Sampling frequency ranges from biweekly to semi-annually depending upon the monitoring site and variable measured.
- General limnological (DO, temperature, conductivity, transparency, velocity) and hydrologic (velocity/discharge) monitoring of habitat rehabilitation projects constructed as part of EMP or Channel Maintenance Plans (Weaver Bottoms, Pool 5).
- Bimonthly and monthly fixed station sampling and quarterly stratified random sampling of water quality of Pool 8 as part of the LTRMP (Soballe and Fischer 2004).
- Longitudinal water quality synoptic surveys to assess main channel water quality and zebra mussel infestation problems during the summer months (July-September).
- Multi-agency soft-sediment macro invertebrate sampling in selected backwater areas during the fall period.
- Site specific intensive water quality surveys for use classifications, mixing zone evaluations, inplace pollutant evaluations, nutrient impairment problems, point source impact assessments, spill response monitoring, contaminant screening assessments and other specialized surveys and evaluations as the need arises.

Core and Supplemental Water Quality Indicators

Core indicators for aquatic life use support include dissolved oxygen, pH, temperature, toxics and fish. Fecal coliform bacteria and general nutrient enrichment problems (nuisance algae) are used to assess recreational use support. In addition, fish tissue contamination data (primarily PCBs and mercury) are considered when identifying impaired waters for the state's 303(d) list. Supplemental indicators include sedimentation, current velocity, nutrients and light penetration-related measurements (transparency, TSS and turbidity) which have a strong influence on the riverine ecosystem (UMRCC 2000 and River Resources Forum, 2004). Some of these indicators are also used to set goals for habitat improvement projects on the river. Future research and evaluation efforts of ongoing monitoring (LTRMP) and future efforts (EMAP and other work) will be necessary to define appropriate ecological indicators (fish, invertebrates, aquatic vegetation or other indices) for the River.

Quality Assurance

Surface water quality monitoring follows program monitoring protocols as identified in the Wisconsin DNR Field Procedures Manual (http://intranet.dnr.state.wi.us/int/es/science/ls/fpm/table.htm) or consistent procedures for monitoring activities not currently identified in the field procedures manual. LTRMP-sponsored monitoring activities follow quality assurance procedures and methods prepared by USGS (Soballe and Fischer 2004). Laboratory analytical methods follow standard operating procedures approved by USEPA.

Data Management

Currently, the main functional centralized database for state-sponsored sediment and water quality monitoring on the Mississippi River is the Lab Portal Database used to manage analytical laboratory results reported to the Department by the Wisconsin State Laboratory of Hygiene. In addition, the Department maintains a Fish/Sediment Contaminant database. These databases are not available to the public or external agencies. The SWMS system will hold and facilitate easy access to all Mississippi River chemistry data currently held in the lab portal. PC-based Mississippi River data can be migrated to SWMS in 2006. It is anticipated that the Department will implement EPA's new STORET system in the future to facilitate external transfer of this data. Substantial electronic data records (primarily spreadsheet files) are compiled and maintained in the field office and are made available to other Department programs, the public and other agencies when requested. Continuous water quality and physical measurements are logged electronically in the field and transferred to PCs and external media upon return from field monitoring episodes. Sampling coordinate information has not been standardized but generally follows Legacy STORET procedures using hand held GPS/DGPS equipment. For the Mississippi River, the coordinate system uses latitude longitude or UTM (NAD 83 or NAD 27 datums) because of their common use by other resource agencies on the Mississippi River.

The LTRMP maintains an extensive database on the Internet through a web-based browser (http://www.umesc.usgs.gov/ltrmp.html#ltrmpdata) and also makes its information available to partnering agencies and the public on a CD (Spatial Query Tool). LTRMP uses UTM (NAD 27) as its geo-location standard.

Data Analysis/Assessment

Water quality monitoring data collected on the Mississippi River have been reported in the State's 305(b) report (future integrated 303(d)/305(b) Report) and through the preparation of site specific or program-related monitoring reports. An updated Use Support Assessment (attainment of water quality standards) for the Mississippi River has not been completed since the original assessment described in the 1996 305(b) Report as a result of insufficient program guidance, especially the determination of the level of use support (i.e. full, threatened, partial and not supported). Similarly, the Department's 303(d) listing process also lacks clear guidance for defining specific impairment problems (i.e. sedimentation, nutrients etc.) or for removing waters from the list. Past efforts for use support or impairment identifications have primarily relied on best professional judgment. There is a current effort underway to provide consistent statewide guidance for preparing future Use Support assessments or Impairment decisions. Further, greater interstate coordination of Mississippi River Clear Water Act assessment and reporting requirements are necessary to foster consistent interpretation of data and for addressing water quality problems affecting the River (UMRBA 2004).

LTRMP offers substantial information on water quality, fisheries, vegetation, invertebrate and other environmental data. However, only a few water quality variables (DO, pH, ammonia) have specific water quality criteria from which to assess standard exceedances. This should be addressed by the upcoming guidance on Water Quality Standards. Further, there are no generally recognized biologic criteria or other ecological indicators identified for the River from which to assess attainment with state water quality standards. Future evaluations of LTRMP, Great River EMAP and other state data (large river IBI/HBI etc) will be necessary to define key ecological indices for defining ecosystem health on the River. Once these ecological indicators are documented and accepted, they then can be considered for future narrative or numeric criteria as well as used in future Clean Water Act assessment and reporting requirements.

Reporting

State-sponsored water quality monitoring activities on the Mississippi River are reported through numerous activities including the integrated 303(d)/305(b) Report, receiving water use classification surveys, responses to WPDES/NPDES permit reviews, technical and summary project reports, web-based reporting,

professional meetings, and intra- and interagency data requests. Sullivan (2000) has described a summary of the WDNR's long-term water quality trends evaluation on the Mississippi River for the period 1977 to 1998. Reports on state-sponsored water quality monitoring work on the Mississippi River are available from the Mississippi River Unit in La Crosse or the WDNR's Central Library in Madison.

WDNR participates extensively with partnering agencies to prepare water quality assessment work and related documents through the Upper Mississippi River Conservation Committee Water Quality Technical Section and Upper Mississippi River Basin Association Water Quality Task Force. Recent examples of interagency reporting activities include a multi-agency water quality assessment of the Mississippi River by the UMRCC (http://www.epa.gov/r5water/umr_wq_assess.htm) and proposed water quality criteria for protecting submersed aquatic vegetation on the Mississippi River (http://www.mississippi-river.com/umrcc/).

Numerous LTRMP water quality monitoring reports and other monitoring component information are available in a web-based format or electronically from USGS (http://www.umesc.usgs.gov/ltrmp.html). USGS has recently prepared draft 10-year summary reports of their water quality, fish, vegetation and invertebrate monitoring programs.

Programmatic Evaluation

Limited internal evaluation of the WDNR's Mississippi River water quality monitoring activities occurs through program reviews, audits and performance evaluations. External programmatic reviews have been primarily driven by EPA-funded or sponsored activities including the recent review of the Upper Mississippi River States' Clean Water Act assessment and reporting procedures prepared by the UMRBA Water Quality Task Force (2004).

The LTRMP monitoring activities are evaluated internally by USGS and the US Corps of Engineers (funding agency) and external partners (EMPCC and LTRMP Analysis Team).

General Support and Infrastructure Planning

Staffing - State-sponsored water quality monitoring and assessment work on the Mississippi River is coordinated and carried out by the Mississippi River Water Quality Specialist position with assistance from Mississippi River Team staff (Water Quality Planner, Wildlife Management and Fish and Habitat Programs) when possible. The water quality specialist position's time for conducting monitoring and assessment activities has become restricted as a result of greater involvement and assignment to interagency work activities in recent years (UMRCC Water Quality Technical Section, UMRBA Water Quality Task Force, EMP Analysis Team, Great River Ecosystem EMAP coordination and planning). There is a need for additional water quality staff assistance to carry out water monitoring objectives identified for the Mississippi River. Opportunities for volunteer assistance may be available.
Laboratory/Funding - Statewide funding for lab support services for state-sponsored Mississippi River monitoring activities has greatly diminished in recent years. Currently only quarterly low-level metals analysis at two sites (Lock and Dams 3 & 4) is funded by the WDNR's statewide long-term trends program. The remaining analytical support needs (ambient monitoring, sediment analysis, nutrient impairment and other special studies) are funded by annual allocations to the Mississippi River Team's Watershed Management program. There will be greater need for lab support services in order to carry out an effective water quality monitoring program on the river in the future. This will be especially true if we employ greater use of probabilistic sampling, analyze for pesticides, "emerging" contaminants or implement new biological monitoring programs to assess use support decisions (i.e. invertebrate enumeration and identification).

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CROSS-RESOURCE MONITORING

SURFACE WATER QUALITY

Author: Ken Schreiber

Status: Partially in Place

A Long-Term Trend (LTT) water quality monitoring network is currently being implemented at 42 river sites and on 68 lakes in the state. An additional monitoring program element, described here, is being added to provide broader spatial coverage of water quality sampling of rivers and streams across the state.

Monitoring Objectives

Clean Water Act objectives:

- Establishing, reviewing and revising water quality standards
- Determining water quality standards attainment
- Identifying impaired waters
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific objectives:

- Collect basic water quality information on Wisconsin lakes and streams
- Establish long-term trends in ambient water quality across the state
- Provide program-specific water quality data at a combination of stream, river and lake sites
- Provide water quality information to support 305(b) reporting and the TMDL/303(d) program

Monitoring Design

All aspects of water quality monitoring including lakes, streams and rivers are incorporated into this element of the Monitoring Strategy. Monitoring will be conducted over a broad spatial scale to provide basic water quality information to various water management programs.

The general stream monitoring strategy will limit sampling to streams that are 3rd order or higher. These streams are generally more likely than smaller streams to receive full body contact recreational use, have a WPDES discharge, and provide at least some information as down gradient indicators of water quality for smaller headwater streams.

Sample sites will be identified to incorporate as many of the data needs of the monitoring objectives as possible. Programs that will benefit from this monitoring effort include:

1. Water quality standards development – phosphorus data will be used to help develop statewide phosphorus standards (to be promulgated by 2007).

2. Effluent limits development – provides data for determining local effluent limits and eventual revision of basin default values currently used in effluent limit development.
3. Water quality standards attainment – provides bacterial and chemical data which can compared with water quality standards. Non-attainment areas would be identified on the 303(d) impaired waters list.

Rivers (Nonwadeable)

Biotic Integrity River Sites - Currently, 108 sites are sampled by the WDNR Integrated Science Services program on 36 rivers annually for fish, habitat and at some sites, macroinvertebrates. Of these 108 sites, 20 are located on the Mississippi River and about 30 were established at or near existing Long-Term Trend (LTT) river monitoring stations. Ambient water quality data will be added to the suite of biological parameters sampled at those sites that are not already being sampled as part of the LTT network. This leaves a balance of about 85 sites for additional sampling of ambient water quality parameters (not including the Mississippi River sites). In order to accommodate this number of sites, the strategy will rely on sampling of core water quality parameters at about 10 sites annually on an eight-year rotational basis. This effort will yield at least 1 site per 15 river miles on each river in Wisconsin.

Field parameters to be measured monthly include dissolved oxygen, pH, turbidity, conductivity and temperature. Volunteers at the 10 river sites will be identified to conduct bacterial sampling for *E.coli* over a 30-day period during the full body contact recreational use season. If volunteers are not available, the bacterial monitoring element of this program will not be implemented. Lab parameters are listed in Table 7.

Long Term Trend (LTT) River Sites - LTT river sites were selected to represent a wide range of ecological and land use categories. The parameters were selected to represent water quality conditions that are influenced by changes in land use and may indicate chronic water quality problems within drainage basins over time. The frequency of sampling varies by site and was determined by looking at past data sets and examining the effects of different sampling frequencies on the strength of trends detected in those data sets. Permanent field staff conduct all monitoring and samples are shipped to the State Lab of Hygiene for analysis (see chapter on Long Term Trends Ambient Water Quality Network).

Monitoring at the 42 LTT river stations will continue as currently being implemented during the first year of the 2005-'06 biennium. The Water Quality Subteam will review previously collected LTT data during 2005 and implement any recommended changes during the second year of the biennium.

Core Water Quality Indicators

Core indicators of the Biotic Index Rivers program are specifically limited to these water quality parameters:

- Dissolved oxygen
- Temperature
- pH
- Conductivity
- Total Phosphorus
- Ammonia N
- Total Kjeldahl N
- Nitrite+nitrate N
- Chlorophyll *a*
- Turbidity
- *E. coli*

Supplemental Water Quality Indicators

- Alkalinity
- Conductivity
- Total Kjeldahl Nitrogen
- Dissolved Phosphorus
- Total Suspended Solids
- Chloride
- Hardness
- Total Rec. Low Level Metals (11+Hg)

Table 7. Water quality parameters for Biotic Integrity river sampling sites.

Designated Use Supported	Metrics Sampled for Biotic Integrity River Sites
Public Health & Welfare	Five samples over a 30 day period: *E. coli*
Fish & Aquatic Life	Monthly Lab Samples: Total Phosphorus, Ammonia, Total Kjeldahl N, Nitrite+nitrate N Chlorophyll-a (June-August only) Field parameters: Turbidity, Conductivity, Temperature, pH, Dissolved Oxygen

Streams (Wadeable)

There are approximately 19,040 miles of wadeable streams that are 3rd order or higher in the state. Ambient stream water quality monitoring will be conducted monthly over a one year period at 50 sites statewide on 3rd order streams and higher. Each year a new set of sites will be identified prior to the sampling season. These ambient water quality stream sites will be created from a subset of the stratified random sites selected for fish and habitat assessments.

Field parameters include dissolved oxygen, pH, turbidity, conductivity and temperature. Volunteers at 10 stream sites will be identified to conduct bacterial sampling for *E.coli* over a 30-day period during the summer recreational use season. If volunteers are not identified, the bacterial monitoring element of this program will not be implemented. Lab parameters are listed in Table 8.

Table 8. Water quality parameters for Streams sampling

Designated Use Supported	Metrics Sampled for Streams
Public Health & Welfare	Five samples over a 30 day period: *E. coli*
Fish & Aquatic Life	Monthly Lab Samples: Ammonia, Total Phosphorus, Total Kjeldahl N, Nitrite+nitrate N Field parameters: Turbidity, Conductivity Temperature, pH, Dissolved Oxygen

Lakes

LTT Lakes – Water quality monitoring is being conducted on 65 lakes statewide to monitor long-term trends and provide regional reference conditions for each defined lake class. These lakes will be used to characterize within-lake and among-year variability in baseline water quality monitoring. WDNR staff will review previously collected LTT lake data during 2005 and implement any recommended changes during the second year of the biennium.

Trend lakes are distributed throughout the state and were selected by the both lakes and fisheries staff in each region, with at least one lake in each of the defined lake classes. At least one lake was selected to represent the "typical" condition of lakes within a region and lake class, if possible. Trend lakes were selected to ensure that these lakes represent the class and will, over the long-term, represent trends for the region.

Trend lakes are sampled annually for water quality with an "expanded" baseline monitoring protocol. Trend lakes should be sampled every 3 years for fisheries parameters, when possible. Water quality parameters include total phosphorus in spring and components of the TSI (total phosphorus, Secchi depth and chlorophyll *a*) and field vertical profiles of dissolved oxygen, pH, temperature, and conductance three times

during the summer (15 July - 15 September). In addition, other supplemental water quality parameters collected once each summer may include conductivity, alkalinity, color, and, on specified lakes, nitrate+nitrite-N and total Kjeldahl-N.

Table 9. Water quality parameters for Long Term Trend Lakes sampling.

Designated Use Supported	Metrics Sampled for Long Term Trend Lakes
Fish & Aquatic Life	Monthly Lab Samples (June-August): Total Phosphorus, Chlorophyll *a* Field parameters: Temperature, pH, Dissolved Oxygen, Conductivity, Secchi depth

Quality Assurance

A project-specific QAPP is not necessary for this program. However, sampling protocols and QA/QC sampling requirements are being followed for each of the parameters sampled as part of the LTT/AWQ monitoring program.

Data Management

Samples collected as part of this program are submitted to the Wisconsin State Laboratory of Hygiene (SLOH). Analytical results are then entered into the laboratory's database and eventually downloaded into the STORET system by WDNR staff in the Bureau of Fisheries and Habitat. All station locations will have established STORET stations that include latitude and longitude coordinates in their station definitions. Annually, the data will be queried from State Laboratory database using the Microsoft Access database engine and exported into a Microsoft Excel database.

Data are available to WDNR staff through the SLOH database soon after laboratory analysis is complete. Data can be downloaded through the WDNR Intranet site via the Lab Data Portal or accessed directly through any database engine that can establish a remote link to an Oracle database. Plans are underway to make the LTT data tables as well as statistical analysis of the data available to the general public via the Internet. These data will be migrated to the Surface Water Monitoring System (SWMS) in 2005.

Data Analysis/Assessment

The primary purpose of the LTT data is to establish a long-term record to determine trends in water quality from a variety of drainage areas and land use types throughout the state. Once water quality data has been collected for a sufficient period of time, the data will be analyzed to determine if trends can be detected indicating a change in mean value of each parameter over time. Water quality chemistry data collected by the program will also be compared to any applicable water quality standards to assess the level of use attainment of Wisconsin waters.

Non-LTT data will be summarized annually and used in effluent limit determinations, water quality standards development and implementation, and 303d and 305b reporting.

Reporting

Data from the water quality monitoring program is available to WDNR staff and the general public through STORET and the WDNR Intranet and Internet. This data can be used for any number of purposes, including 303(d) list development, the integrated 303(d)/305(b) Report, stream classification and use attainability analyses, TMDL development, water quality-based effluent limits in WPDES permit drafting, technical reports, brochure development and television & news media reports. WDNR staff are currently compiling the first report of the LTT/AWQ data, which will be included in the upcoming 303(d)/305(b) Report and updated regularly thereafter.

Programmatic Evaluation

As the program continues, an integral part of the data analysis will be to continually reevaluate the sampling regimen and make adjustments to the sampling frequencies based on the data collected to that point and the ability to detect trends within the data set.

General Support and Infrastructure Planning

Staff and Training: Staff support to collect the river and stream samples would primarily come from existing Watershed Management (WT) FTE staff or WT LTE allocations that are already provided to the regions. Lake sampling is primarily supported by Bureau of Fisheries and Habitat FTE and LTE staff. Volunteers will be identified for some of the monitoring in this program, with consideration for quality assurance, accessibility and safety factors.

Laboratory Resources & Funding: Approximately $110,000 of the SLOH basic agreement lab allocation currently supports the LTT rivers program. An additional $44,000 in lab support will be provided to the Lakes monitoring program. The new river and stream monitoring effort will require $56,000 in lab support. These allocations are expected to increase at a rate equivalent to the increase in analytical costs at the State Laboratory of Hygiene.

Program Gaps

Under the proposed water quality monitoring strategy, approximately 300 sites will be sampled over a 6 year period, providing one site per 63 miles of streams of 3rd order or greater. This strategy will require about 38 years of monitoring to provide full coverage of one site per 10 miles of streams that are 3rd order or higher. Monitoring of streams smaller than 3rd order will not be sampled as part of this strategy.

CONTAMINANTS IN FISH TISSUE

Author: Candy Schrank

Status: Currently in Place

This program has been in place since the mid-1970s. Current funding allows for return monitoring of advisory sites and some new site monitoring for PCBs and mercury. Although additional funds would allow expanded coverage and more detailed sampling within advisory sites, field collection costs would increase and additional staffing to handle fish and maintain the database would be required. Current funds allow for limited monitoring of dioxin/furan and emerging chemicals. Overall, fish are collected from approximately 50 to 100 sites each year. Current analyses include about 600 samples analyzed for mercury, 350 for total PCBs, 30 for banned pesticides, 20 for dioxin/furan analysis and 10 for PBDEs. Collection of fish for contaminants is not funded through the fish contaminant program funds but is achieved through fieldwork conducted for baseline, treaty, or other fisheries surveys.

Monitoring Objectives

The objectives of the fish contaminant program include but are not limited to protection of fish consumers, resource management, and environmental protection.

Clean Water Act Objectives:

- Determining water quality standards attainment – determine 'fishability'
- Identifying impaired waters – identify waters with bioaccumulative chemicals
- Identifying causes and sources of water quality impairments – fish tissue monitoring assists in determining sources or location of contaminated sediments.
- Supporting the evaluation of program effectiveness – fish tissue monitoring provides information to evaluate remediation of sediments. Fish tissue monitoring has in the past reflected efforts to control direct discharges of bioaccumulating chemicals. Fish tissue monitoring may also be helpful in evaluating success of control of other sources of pollutants (e.g. mercury and emerging chemicals but that has not yet been demonstrated.

Specific Objectives:

- Protection of fish consumers
  - Determine levels of bioaccumulative contaminants in the edible portions of fish and compare these levels to health guidelines as determined by the Wisconsin Division of Health.
  - Issue fish consumption advisories for certain species and sizes of fish from given areas where the concentrations of chemicals in the fish flesh exceed the health advisory levels.
  - Evaluate contaminant levels in commercial fish, issue reports to commercial fishers, the Wisconsin Department of Agriculture and the U.S. Food and Drug Administration (FDA), and issue commercial fishing bans where it is determined that all fish of a given species exceed FDA tolerance levels from a particular site.
- Resource Management
  - Evaluate the health impact of contaminants on piscivorous fish and wildlife by analyzing forage fish consumed by these species.
  - Evaluate stocking programs to promote practices which will lead to a reduction in the potential for accumulating contaminants.
- Environmental Protection
  - Establish baseline levels and determine major trends of contaminants
  - Identify potential sources of contaminants including industrial discharge, sediment, landfills, and groundwater contamination.
  - Evaluate the effectiveness of remedial programs on bioaccumulation potential and impacts of control of discharges to receiving waters.

- Evaluate the impact of air emissions (atmospheric deposition) to surface waters. Examples include municipal incinerators (dioxin and mercury), coal combustion (mercury), and chor-alkali plants (mercury).
- Evaluate the effects of past/present use of pesticides.

Monitoring Design

The monitoring design consists of different components depending on the purpose of the monitoring (baseline, advisory, Great Lakes, or trend), the area of the state or the waterbody type (inland lakes, rivers, Great Lakes), and also varies depending on the contaminant (mercury, PCBs, pesticides, dioxin/furans, and emerging chemicals). In order to determine the upcoming year's needs for fish contaminant analysis, a number of environmental and resource program managers are consulted to determine the sampling regime. Each year, a collection schedule is formulated to provide guidance to field staff on locations where fish samples are needed to fulfill the monitoring design.

Baseline Fish Contaminant monitoring focuses on sampling new sites (not previously assessed for contaminants) and sites where contaminant data is old (more than 15 years old) or limited, or where existing data shows that concentrations may be high and additional data would be beneficial to determine advisory needs. Collections of fish from lakes and rivers for contaminant analysis are coordinated with the baseline schedule along with others fisheries surveys like treaty and other assessments, to allow savings in field costs. In general, top-level predator species are first selected for contaminant monitoring and additional species may be added depending on the site characteristics and availability of past contaminant data and existing advisories for the specific waterbody. Most fish are analyzed as edible portion forms unless there are trend data that need to be maintained. Samples collected at baseline sites are primarily analyzed for mercury content but some samples are also analyzed for PCBs and other contaminants, especially for flowing waters. Existing fish contaminant data shows the presence of mercury at low levels in most fish and higher concentrations in some larger top-level predator fish. The goal for return frequency to baseline sites with limited or suspected high mercury concentrations is 10 to 15 years or when fisheries management schedules allow more frequent monitoring. In these cases, additional samples may be taken to fill in data gaps.

Advisory Fish Contaminant Monitoring refers to monitoring of fish for contaminants where PCB based fish consumption advice is in place and monitoring is conducted to update consumption advice. This monitoring is generally conducted in major industrial rivers and locations where remediation may be necessary or underway. The inland (non-GL or non-border waters) locations are generally monitored on a five year rotating basis in order to update the data for advisories and for trend monitoring. More frequent sampling can occur in areas where remediation is imminent. In addition, specific biennial monitoring designs are defined for Lakes Superior and Michigan (see Great Lakes below). Samples collected at PCB advisory sites are primarily analyzed for PCBs and mercury content but a subset of samples are analyzed for dioxin/furan congeners, banned pesticides, and emerging chemicals. Species are chosen based on data gaps and advisories for the site, angler survey data, availability of species, desire to maintain consistency with past collections, and regulations for a specific water body.

Great Lakes and Mississippi River fish contaminant monitoring calls for collection of fish for contaminant analysis on a biennial basis. The collection schedule includes both gamefish and forage fish from Lake Superior and Lake Michigan, and the Mississippi River; salmonid species biennially from Lake Michigan and Green Bay; alewife and bloater chubs from these same areas. The collection schedule includes Lake trout, siscowett, sculpins, and herring from the open waters of Lake Superior and walleyes from tributary areas along Lake Superior. The collection schedule includes species under advisory for the Mississippi River in coordination with Minnesota collection efforts. Samples collected at Great Lakes and the Mississippi River are primarily analyzed for PCBs and mercury content but a subset of samples are analyzed for dioxin/furan congeners, banned pesticides, and emerging chemicals.

In addition, the Department has been cooperating with the EPA Great Lakes National Program Office since the late 1980s to determine trends and geographic patterns of contamination, to provide information for

health advisories and for tracking contaminant levels in key salmon species. The Department participates in some components of this monitoring by collecting fish, processing of samples, and shipping samples as defined in inter-agency agreements. This includes collection of coho or chinook salmon at three Great Lakes tributaries according to the inter-agency agreement. In addition, DNR collects lake trout from Lake Superior every other year. EPA provides the analytical services for PCBs, chloro-organic and other compounds. The data generated by this program are used for trend analysis and consumption advisories when the results are shared with WDNR.

Core and Supplemental Water Quality Indicators

Fish tissue concentrations of mercury and PCBs are core indicators; however, tissue concentrations are difficult to portray as indicators because of the complexity of availability, bioaccumulation, and fish growth and migration. Tissue concentrations may vary as a result of non-water quality factors and therefore appropriate analyses must be conducted to use tissue concentrations as an indicator of water quality. In addition, dioxin/furan, banned pesticides, and some emerging chemicals are also analyzed on a limited basis.

Quality Assurance

Pertaining to fish contaminant monitoring, quality assurance processes may be found in sampling and procedure documents describing the fish contaminant monitoring program and the procedures for each of the analytical laboratories that provide analytical services. The Wisconsin State Lab of Hygiene, a certified laboratory with approved quality assurance procedures, completes most fish contaminant analyses.

Quality assurance processes may be found in sampling and procedure documents describing the fish contaminant monitoring program and the Department's quality assurance programs. See the following items for more information.

- WI DNR Field Procedures Manual. Intranet Edition. Part B: Collection Procedures. 1005.1 Fish Contaminant Monitoring Program – Field and Lab Guidelines. http://intranet.dnr.state.wi.us/int/es/science/ls/fpm/1005_1.htm
- Fish Contaminant Program Procedural Guidelines. Wisconsin Department of Natural Resources Manual Code 3611.1
- Wisconsin Department of Natural Resources Quality Management Plan. http://intranet.dnr.state.wi.us/int/es/science/quality/qmp/
- Wisconsin Department of Natural Resources Field Procedures Manual. Intranet Edition. Part A. General Information. I Introduction to Sampling. B. Sampling and Quality Assurance Planning. http://intranet.dnr.state.wi.us/int/es/science/ls/fpm/I.htm#IB

Data Management

Contaminant data are stored in the Department's fish-sediment contaminant database consisting of a series of Oracle tables and managed on a client-server system. Data are available upon request after field verification and Department analyses are completed.

The Fish-Sediment Contaminant Database contains the results and associated sample and site information for contaminants analyzed in fish tissue. It contains contaminant results for over 27,000 fish samples as of 2003 collected in Wisconsin waters from around 1970 to the present. The data is contained in ORACLE tables that are linked by defined relationships (relational database).

Sample results information is captured by the State Lab of Hygiene on their Laboratory Information Management System (LIMS) and made available to DNR through the Lab Data Entry System (LDES). Other laboratories provide required results data in a similar system that is batch uploaded into the LDES. Automated systems transfer the results to the fish contaminant database for long-term storage and manipulation. More information on the LDES system structure is available at: http://intranet.dnr.state.wi.us/int/es/science/ls/lab_data/help.htm . The home page for this data system is located at: http://intranet.dnr.state.wi.us/int/es/science/ls/fpm/VII.htm

DNR staff can access the fish contaminant data using an ORACLE client-server system that can be installed on DNR computers. The server system allows data entry for locational data and creation of samples, data editing, sample tracking and tallying, and data querying and extraction. After installing this server system, any Department employee can query the data using the logon i.d. "read" and password "only". Water Division staff may become registered users after obtaining an ORACLE password. .

The client-server system allows Department staff to query the database using the ORACLE client server system by selecting the location, species, collection date, chemical parameter, and other restrictions. For output you can select an onscreen report that can be viewed or printed, a PDF file, or an ASCII (CSV) file. PDF files can be found under your C:\Dnrapps\Wr539\Data folder. ASCII files can be found under NRCENTRAL\Prodgin00\Utildir.

Verified data are also available to other agencies and the public upon request specifying the desired collection dates, geographical area, species and form of fish, and parameters.

Data Analysis/Assessment

Each year, the Department reviews newly obtained contaminant data in the context of existing data and advisories. The WDNR, in a cooperative effort with the Wisconsin Division of Public Health in the Dept. of Health and Family Services (DHFS), determine whether a sample is of public health significance. When concentrations of contaminants exceed health guidelines, WDNR and WDHFS jointly issue a fish consumption advisory for the appropriate water body. The process of collection, data management and interpretation, and policy development is outlined in Department manual code 3611.1.

PCBs and mercury are responsible for most of the advisories for Wisconsin waters although several waters are also listed due to dioxin or chlordane contamination. Where two or more contaminants exceeding their respective health guidelines are found, the contaminant with the most stringent health advice is used for giving advice. Additivity of multiple contaminants is not considered at this time except in evaluating dioxin toxicity.

PCB advisories hare issued according to the "Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory" (Anderson, et. al., 1993) since 1997. Prior to that, the percentage of samples that exceeded FDA's 5 and 2 ppm tolerance level was assessed to determine the appropriate consumption advice.

In 2001, a new reference dose (RfD)/meal frequency approach was adopted for mercury based advisories. This approach resulted in a statewide general fish consumption advisory in addition to site specific advice where mercury levels require more specific advice. Two different RfDs are used, one for the sensitive population and one for the general population. The new statewide advisory was adopted after new information showed that lower amounts of mercury were harmful to developing fetuses and young children (National Research Council and EPA). The new general statewide advisory was based on the new effect levels and typical levels of mercury found in Wisconsin fish while considering harvest, consumption patterns, fishing regulations and other factors.

From 1985 to 1999, mercury advisories were developed according to "Wisconsin Mercury-Fish Consumption Health Advisory" (Anderson and Olson, 1986) and tissue criteria ranged from 0.5 ug/g, to 0.75 ug/g, to 1 ug/g and the associated advice varied by consumer group.

While a one-time sampling event may lead to the issuance of an advisory, levels of a particular contaminant must decline below the state criterion for at least two years (of sampling) within 5 consecutive years before an advisory is rescinded or changed.

Reporting

Analyses and reports are prepared on a project specific or as needed basis. These reports vary in their purpose: e.g. site-specific, or species-specific, contaminant-specific, or statewide summaries of contaminants,

contaminant-specific trend analysis, advisory determination, etc). Appropriate statistical analyses are determined specific to the purpose of the data analysis and reporting. The reports are available upon request and sometimes remain in draft form as additional data are collected.

The following reports are updated each year after new data is evaluated:

- Annual review of new data in context of existing data, advisories and other information to determine necessary advisory updates and publication of the advice.
- Data summaries for specific advisory or remediation sites or for specific fish contaminants on a statewide or regional basis on an as needed basis.
- Annual update of the report, Wisconsin's Fish Contaminant Monitoring Program and Advisory Summary.
- Reporting of fish contaminant monitoring and fish consumption advice is included in the biannual 305b report to congress.
- Completion of EPA's annual survey for the Listing of Fish and Wildlife Advisories
- Reporting to EPA Region V through the ENPPA program.
- Reporting of accomplishments through the Department's biennial workplanning process.

In addition, the data and reports from the fish contaminant monitoring are used by various Department programs including reporting of information necessary for the 303d and other Clean Water Act requirements and sediment remediation programs.

Programmatic Evaluation

The fish contaminant monitoring program operates within the framework of the Water Division biennial workplan. Any changes to the protocol or strategy are recommended to the Water Division Monitoring Team. Reviews of workplan performance are completed annually, to evaluate job completion. In addition, program staff participate in regional and national workshops and evaluations of fish contaminant monitoring programs.

Overall review of monitoring programs occurs each time a component of the program is evaluated (e.g. Great Lakes trend monitoring, baseline monitoring, advisory updates). Review of state monitoring programs is also a part of the Department-EPA ENPPA process. These processes allow annual and biennial workplanning goals to be established. In addition, ongoing discussions of monitoring occurs with other groups like the Division of Health, the Great Lakes National Program office and EPA programs, contacts with other fish contaminant monitoring coordinators including coordinators from the states adjacent to Wisconsin.

General Support and Infrastructure Planning

Fish contaminant monitoring has remained at a fairly consistent basis since about 2000. The primary focus has been on PCBs, mercury with limited analysis for banned pesticides, dioxin/furans, and emerging chemicals. Currently the program is funded by a mix of funds. In 2003, the fish contaminant program depended on the following basic activities supported by different funding sources:

> *Collection of fish* – supported by fisheries staff and program funding as they conduct routine monitoring. The cost to collect fish is not tracked because these activities are for other purposes and supported by a variety of fund types. Fish collection is coordinated with these other activities to minimize field costs and uses equipment, staffing, and supplies from fisheries funded programs.
> *Analysis of Samples* – supported by the Wisconsin State Laboratory of Hygiene basic agreement services. Also supported by EPA PPG 106 funds for specialized analyses through contracts with private laboratories (primarily for dioxin and furans). Wisconsin uses approximately $120,000 worth of services annually on laboratory chemical analysis of fish tissues. Most of the state's samples are analyzed on a non-fee basis at the Wisconsin State Laboratory of Hygiene under a basic agreement

($100,000 equivalent service). Analysis of certain compounds requires the program to contract with other laboratories.
Supplies, Fish Processing, Fish Processing Facilities and Advisory Materials – Supported by EPA PPG 106 funds totals about $30,000.
Program management – Supported by 1 FTE WI DNR staffing supported by GPR funds

The mix of funding that is used to support these activities has changed over the years to reflect changes in funding levels. Over the 35 years of the program fish have been collected from a total of 1549 different sites. Many of these sites have multiple collections over the year to address changes over time. However, monitoring has not been designed to specifically address changes over time.

Program Gaps
Gaps include limits on the number of sites where fish can be collected each year, the number of fish that can be processed, and the number and types of analytes that can be assayed on each sample. In addition, gaps include the ability to monitor fish extensively enough to specifically examine differences on a geographical basis or for specific sites in more detail to examine changes in fish contaminants over time at a particular sites or area.

Additional FTE to manage the program would be necessary to expand the current program to handle and process fish, manage the database, and evaluate results. In addition, funds would be required to increase the current level of effort to collect fish, handle and process fish, and add analytes.

References

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PATHOGEN MONITORING ON INLAND BEACHES

Author: Toni Glymph

Status: Pilot Program in Place; Temporarily Funded

In 2002 inland State Park beaches were monitored once per week in an effort funded through the Bureau of Parks. In 2003 a pilot beach monitoring program modeled after the Great Lakes beach program was developed and implemented with 10 inland State Park Beaches.

Monitoring Objectives

Clean Water Act Objectives

- Establishing, reviewing, and revising water quality standards
- Determining water quality standards attainment
- Identifying impaired waters

Monitoring Design

Ideally, each public beach throughout the state would be monitored every summer. However, given limited funds, beaches are ranked based on usage to determine which areas are highest priority for monitoring. An initial stage of this project would involve identification and ranking of all public beaches in the state. Once beaches are ranked, they would initially be monitored during storm events to determine whether water quality at individual beaches is adversely affected by storm events. For those at which this is the case, advisories will be posted after each rain event. After this initial determination, sampling during storm events is not necessary, and the focus would shift to regularly scheduled monitoring. In order to make the best scientific decisions about water quality as it relates to bacteria, a cross section of samples should be collected on each water body. The geometric mean criteria require that at least 5 samples collected within a 30-day period, throughout the recreational season.

Recreation occurs in many forms; hence EPA has provided several approaches to managing risks in recreational waters in its *Implementation Guidance for Ambient Water Quality Criteria for Bacteria.*
The recreational use options are provided in Table 10:

In the event that Wisconsin adopts one or more of EPA's approaches, monitoring should be implemented and must be designed to assess recreational waters for the appropriate recreational use category or subcategory.

Table 10. Recreational use, criteria, and supporting analysis.

Designated Use	***E. coli* Criterion**	**Supporting Analysis**
Primary Contact Recreation		
Identified Public Beach Area	235 cfu/100mL sample maximum 126 cfu/100mL geometric mean	None
Other Primary Contact Recreation Waters	Maximum Criteria 941 cfu/100mL sample maximum 206 cfu/100mL geometric mean	None
Seasonal Recreational Use	Primary contact recreation criteria apply during specified recreational season; secondary contact recreation criteria apply rest of the year.	Information explaining choice of recreation season (e.g., water and air temperatures, time of use, etc.)

Recreational Use Subcategories		
Exceptions for high flow events	Exception to criteria at high flows based on flow statistic or number of exceedances allowed.	Use Attainability Analysis
Wildlife Impacted Recreation	Criteria reflecting natural levels of bacteria.	Use Attainability Analysis and data demonstrating wildlife contributes a significant portion of the fecal contamination
Other Categories of Recreation		
Secondary Contact Recreation	Criteria sufficient to protect the use but not greater than 5 times the primary contact recreation value	Use Attainability Analysis

Core and Supplemental Water Quality Indicators

Following are core indicators that should be evaluated to assess recreational water quality:

- Wisconsin recreational water standards have historically been based on bacteriological criteria. The State is in the process of changing from its current criteria using fecal coliform bacteria to using *E. coli* bacteria. After adoption of new criteria, the core indicator that will be used to determine attainment of recreational water standards will be *E. coli* bacteria.
- Nuisance plant growth (Cladophora, algae blooms, excess aquatic plant growth)
- Nutrients (phosphorus, TKN, ammonia)
- Chlorophyll A
- Turbidity (Secchi depth)
- Runoff control (landscape)

If Wisconsin decides to adopt different recreational use categories or subcategories, additional indicators will be required.

- Water temperature
- Air temperature
- Rainfall
- Waterbody flow
- Waterbody velocity

Quality Assurance

Monitoring ambient water for *E. coli* bacteria is not covered under the Department's Quality Management Plan. It is however covered under the Quality Assurance Project Plan for the Wisconsin Beach Monitoring Program.

Data Management

The DNR LabData System stores all data analyzed by the State Lab of Hygiene, including water quality data for bacteria indicators. This may include, total coliforms, fecal coliforms, *E. coli* or enterococci. Most of the data comes from individual beach monitoring efforts throughout the State, from individual studies conducted in certain waterbodies or compliance monitoring. The data is entered within 24 hours of analysis and is available to State Lab personnel and WDNR staff on the WDNR intranet at http://prodmtin00.dnr.state.wi.us/pls/prod1/pk_eq508_ldes$.startup. The data will be stored in the SWMS system in the future, and will flow to USEPA from there.

Collecting samples for analysis of fecal coliforms or *E. coli* is currently not included in our baseline monitoring strategy for lakes, rivers, and wadable or non-wadable streams.

Data Analysis/Assessment

Currently, waters are not being assessed for attainment of water quality standards for bacteria, and there is not yet any standard methodology that Wisconsin has for assessing waters for attainment. There are a few water bodies that are on the 303(d) list for bacteria, namely fecal coliforms. Requests to place these waters on the list came mostly from citizen groups reviewing data generated from individual research studies on these particular water bodies, not from data collected as a part of a formal monitoring plan. WDNR staff are currently working on establishing a formal process for listing waters on the 303(d) list; however, staff time will still need to be allocated to data analysis in order to determine which waters should be listed.

Reporting

Any data that has been assessed is usually reported in the integrated 303(d)/305(b) Report.

Programmatic Evaluation

Currently, there is no formal evaluation method.

General Support and Infrastructure Planning

Staff and Training - Currently one staff person is assigned to bacteria standards. Ultimately about 4 FTEs will be required for full implementation. WDNR would like to develop a program for collection of beach pathogen data by local public health officials and volunteer groups, following WDNR methodologies. Standard sampling and analytical protocols for monitoring *E. coli* were developed for the beach-monitoring program. Training will be required for field staff collecting samples. Several methods have been approved for analysis. Currently there is ongoing training developed by our Science Services section, for laboratory staff. Data can be stored in the current lab portal database however assessment methodology will need to be developed and the data will need to be evaluated and assessed.
Laboratory Resources/Funding - It is difficult to determine the funding needs for monitoring lakes and streams for *E. coli*. The Wisconsin State Lab of Hygiene is trained and equipped to test for *E. coli*. The cost of samples average about $20.00 per sample, and at least 5 samples will be taken at each site. Currently it requires approximately $350,000 to monitor 113 Great Lakes beach areas for *E. coli*. Statewide, there are significantly more inland waterbodies to monitor, and the number of sites to be monitored each year has yet to be determined. BEACH Act funding used for the Great Lakes beaches is not available for inland beaches and is only guaranteed through 2005. Funding sources for the 2003 pilot beach monitoring program on 10 inland State Park Beaches include:

- State Lab of Hygiene (SLOH) General Program Revenue (GPR) DNR Basic Agreement
- SLOH GPR Health & Family Services (HFS) Basic Agreement
- DNR Conservation Segregated Fund
- HFS Performance Grants

References

USEPA, 2002. Implementation Guidance for Ambient Water Quality Criteria for Bacteria. U.S. Environmental Protection Agency. EPA-823-B-02-003. May 2002 Draft.

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USEPA. 1984. Health Effects Criteria for Fresh Recreational Waters. U.S. Environmental Protection Agency. EPA-600/1-84-004.

Cabelli, V. J. 1983. Health effects criteria for marine recreational waters. U. S. Environmental Protection Agency, Cincinnati, OH. EPA-600/1-80-031.

GROUNDWATER

Author: Laura Chern, Jeff Helmuth

In October 2004, the Bureau of Drinking and Groundwater, in conjunction with several other state and federal agencies, produced a report titled: *Components of a Groundwater Monitoring Strategy for the State of Wisconsin (Groundwater Strategy)*. This report details programmatic goals, several components needed to meet those goals, and phases for implementation. Use of the strategy by local, state, and federal agencies and by researchers will allow for better data management and sharing, a common protocol for collecting high quality groundwater data and expansion of the fixed monitoring network. Much of the document is reproduced here; however, for the original format and further details please reference the original document.

Status: Partially in Place

Some of the components detailed below that are needed to create a comprehensive groundwater monitoring program already exist and are maintained by state and federal agencies. These include a fixed network for groundwater level monitoring, a fixed network for surface water monitoring, and a water use reporting program. Other components, such as a fixed network for monitoring groundwater quality and a data management process, need to be implemented.

Monitoring Objectives

Implementation of the Clean Water Act (CWA), Wisconsin's Groundwater Law (Chapter 160 Wisconsin Statutes) and recently enacted Water Quantity legislation (2003 Act 310) all require an understanding of groundwater systems that involves monitoring. The CWA gives Wisconsin DNR primary responsibility for protecting and restoring water quality including monitoring and assessing the state's waters and reporting on their quality.

Clean Water Act Objectives

- Establishing, reviewing and revising water quality standards
- Determining water quality standards attainment
- Identifying impaired groundwater
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Chapter 160 of the Wisconsin Statues requires the DNR to work with other agencies and the Groundwater Coordinating Council (GCC), to develop and operate a system for monitoring and sampling groundwater to determine whether harmful substances are present (s. 160.27, Wis. Stats.). Recently enacted groundwater quantity legislation (2003 Wisconsin Act 310) directs the DNR to issue well approvals and track water use for high capacity wells. The objective of the monitoring strategy is to coordinate groundwater monitoring between all agencies interested in groundwater quality, quantity and use in Wisconsin.

In this light, the *Groundwater Strategy* defines three specific goals, described below.

Goal 1: Provide and maintain sufficient, high quality groundwater data to evaluate spatial and temporal trends in groundwater quality, quantity and use

Agencies need high quality data to make changes to groundwater management and protection policies in response to changing trends in groundwater quality, quantity and use. The components used to meet this goal must be flexible enough to accommodate new contaminants and threats as they are recognized. Examples of how the data will be used include:

- Evaluating groundwater protection programs;

- Evaluating public health protection programs;
- Documenting the presence of new pollutants;
- Assessing groundwater quality in DNR basins;
- Tracking groundwater levels in groundwater management areas; and
- Evaluating water use and its impacts on groundwater levels.

Goal 2: Provide high quality data for a more complete understanding of groundwater systems
An understanding of hydrogeology drives state and local policy and management decisions that affect drinking water, fisheries and wildlife habitat. Research aimed at understanding flow systems at different scales, local and regional, helps local resource managers make decisions that protect all water resources. Examples of how this data will be used include:

- Locating and preserving groundwater recharge areas to sustain groundwater quantity;
- Understanding the fate and transport of natural and human-induced contaminants;
- Understanding how land use practices affect groundwater quality and flow; and
- Developing and evaluating management alternatives.

Goal 3: Provide tools to make groundwater data accessible to citizens, policy makers and resource managers
The public's understanding of groundwater has greatly increased since the Groundwater Law was passed in 1984. The next step is to make local groundwater data easily accessible to citizens, policy makers, researchers, and resource managers so that all stakeholders have the information they need to increase protection of the resource and public health, whether on a local or statewide level. To attain this goal we will:

- Make groundwater data accessible to citizens, policy makers and resource managers via a website;
- Develop tools to help educate citizens about statewide and local groundwater quantity and quality problems; and
- Involve partners in groundwater monitoring to increase awareness of groundwater.

Monitoring Design

Five of the components listed in *Components of a Groundwater Monitoring Strategy for the State of Wisconsin* are outlined below (Components 2-6 of the *Groundwater Strategy*). The other components of the *Groundwater Strategy* are addressed within the Data Management, Data Analysis, and Reporting sections of this document. Following these components, a phased implementation outline is provided.

A Fixed Network of Groundwater Level Monitoring Locations (meets goals 1 and 2)
Monitoring will include measurement of groundwater levels in all of Wisconsin's water-bearing formations reflecting both water table conditions and deep confined and unconfined aquifers. It should include areas of groundwater development such as urban and rural areas with large withdrawals and undeveloped areas such as forestland.

The USGS and Wisconsin Geological and Natural History Survey (WGNHS) have maintained a fixed network of 117 monitoring wells since the 1940s. The network was designed to monitor water levels in the upper most aquifers. In 2000 the USGS evaluated the network for well location, condition and presence of geologic logs. They recommended that 48 wells be abandoned and replaced by wells in different locations. The cost estimate for improving the observation well network is shown in Table 11 below.

Table 11. Estimated costs for observation well network improvements.

Well abandonment	$500/well
Real time monitoring equipment	$750/well
Siting (professional time)	$700/well
Drilling and well installation	$2000/well

The total estimated cost of $200,000 could be spread out over 3 to 5 years. Costs may be lower if existing wells can be added to the network. This new, improved observation well network will monitor water levels in shallow, unconfined aquifers in each of Wisconsin's 23 basins and improve our understanding of groundwater flow systems in each basin. Approximately 20 wells are measured daily with electronic recorders, three of which have Real-Time recorders; the remainder are measured on a weekly, monthly or quarterly basis by staff or observers. This information will allow us to look at groundwater quantity trends.

Monitoring the cone of depression in areas where the water table is declining will require additional monitoring wells. These wells will be installed in the deeper bedrock aquifers and may require casing. Approximately 10 new wells will be installed at a cost of about $40,000 per well. The total estimated cost would be $400,000.00. This cost may be less if existing wells can be used. The yearly combined cost for maintaining a fixed network of 115 water table wells and 10 deep wells to monitor cones of depression will be about $120,000. This includes rehabilitating wells, training staff and replacing damaged wells.

This component meets goals 1 and 2 by providing high quality groundwater level data over a long period of time. Currently the USGS, DNR and WGNHS maintain and monitor a fixed network. Improvements to the network have been proposed above and funding is being looked at by the different agencies.

Statewide Assessment of Groundwater Quality (meets goals 1 and 2)
Numerous efforts have been made to characterize groundwater quality on a statewide basis. These efforts include sampling of private, public and monitoring wells. An excellent example is described in the Department of Agriculture, Trade and Consumer Protection's report, *Agricultural Chemicals in Wisconsin Groundwater* (2002). DATCP used a statistical procedure for stratified random sampling of private wells to obtain a representative sample of all Wisconsin groundwater for pesticide analysis. The sampling protocol is statistically sound, and uses a sophisticated well selection procedure to determine the extent of monitoring within a sampling stratum. Sampling strata are defined as the geographic area of interest. Examples of strata include aquifers, watersheds, basins, or agricultural statistics districts.

Briefly, stratified random well selection works like this: parcels are randomly selected and the well nearest the center of the parcel is selected for sampling if permission is given by the well owner. If there is no well or the owner refuses to have the well sampled, another parcel is selected by spiraling out clockwise around the original parcel. If appropriate sampling strata are used, this approach can be used to select wells for sample collection and analysis for non-agricultural water quality parameters as well. The number of samples collected in each statistical stratum varies based on many things including prior detections, number of acres in a certain land use or number of acres in a watershed or basin. Frequency of sampling also varies based on the hydrogeology of the area and the nature of the contaminant.

The DATCP pesticide surveys of 1994, 1996 and 2001 used a fifty-percent rotation scheme in which half of the wells in the 1996 and 2001 surveys were part of the previous survey and half were new wells. This allowed detection of changes in pesticide levels over time.

The cost for sample collection and analysis will vary depending on the parameters analyzed. As a rough estimate, it would cost about $180,000.00 per year. Parameters may include major cations and anions, indicator parameters, and the contaminants of special interest. This component will meet goals 1 and 2 by providing a flexible means of looking at groundwater quality trends and better defining groundwater contaminant transfer in flow systems. The Monitoring and Data Management Subcommittee of the GCC will help better define how the data will be made accessible.

A fixed network of water quality monitoring sites (meets goals 1 and 2)
Stratified random sampling of private wells may lead to selection of fixed monitoring sites for long term monitoring. Fixed sites chosen to consider the effect of different land use practices will be part of the fixed network. Existing research and monitoring project wells could also be incorporated into the fixed network as well as public water supply wells (e.g. sentinel wells). Each location may have more than one well to monitor

specific parameters. This network may change somewhat with time. Costs at this time are difficult to estimate.
This component meets goals 1 and 2 by providing groundwater quality data in areas of concern over time. More details on this component will need to be worked out by the GCC and it's subcommittees.

Surface water monitoring stations (meets goals 1 and 2). These stations overlap with those used in the WDNR stream monitoring program. This monitoring is conducted by USGS and DNR.
Surface water monitoring stations provide stream flow data used to:

- Calibrate groundwater flow models
- Assess basin water resources management decisions
- Model the effect of development on watersheds
- Determine the effect of groundwater use on stream flow and fisheries habitat.

The USGS has evaluated the current stream gaging network and determined that 25 additional monitoring stations are needed on medium-sized streams. The cost of adding 25 new stations and maintaining them is $250,000. Proposed station locations are based on the need for stream flow data for DNR Watershed and Fisheries and Habitat programs. An additional $70,000 per year is needed to collect low flow measurements in small streams as needed to support long-term monitoring. Funding for changes to the network is not currently available from the USGS or DNR.

This component meets the needs of goals 1 and 2 by providing long term data on groundwater baseflow to surface water at fixed locations. The USGS and DNR currently maintain a surface water monitoring network and will continue to do so. Other partners have access to the data on a website.

Water use reporting (meets goals 1 and 2)
The purpose of water use reporting is to manage groundwater at local and regional levels. Data are used to evaluate impacts of proposed wells, monitorwell approval conditions, identify trends, as input for groundwater flow models, develop hydrologic budgets for watersheds and basins and improve water use estimates. We currently have good data for municipal water supply systems but the reporting should be expanded to all high-capacity (>100,000 gal/day) wells including:

- Industrial and commercial users
- Irrigators
- Non-irrigation agricultural users

This component meets goals 1 and 2 by providing groundwater use data to help determine water quantity trends and define groundwater/surface water interactions. New well fees may provide funding for data this collection.

Implementation Outline

The following four phases illustrate how the monitoring network will be implemented and used. Phases one and two will assess groundwater systems and determine fixed monitoring locations as described in phases three and four. Parts of phases 1 and 2 are completed or started for some basins or deep aquifers.

Phase I: Baseline Assessment of shallow aquifer system by 23 major basins
Most groundwater management decisions made in Wisconsin are based on data collected for other purposes and published studies done in other states. As groundwater sustainability becomes more critical it is important to use more reliable and applicable data to make groundwater and land use decisions. Assessing the condition of shallow groundwater in each basin is the first step toward groundwater sustainability. Initially, a pilot basin will be assessed to determine the best way to do a groundwater assessment for each basin. An assessment of each of the 23 basins may include the following:

- Mining of data in existing databases to determine contaminants in the basin
- Evaluating potential contaminants present in the basin due to land use

- Determining water quality using a selection of wells (private, public, or monitoring wells) for major cations and anions and other contaminants of concern
- Modeling groundwater flow and surface water interactions
- Identifying fixed monitoring stations (surface water and groundwater) for water quality and quantity
- Evaluating water use
- Making the data and assessment public

Phase II: Baseline Assessment of Deep Aquifer Systems
The next step toward better management of Wisconsin's groundwater is evaluating the deeper aquifers. Because deeper aquifers are not impacted as quickly by land use and because deep groundwater divides usually differ from surface water divides, it is more appropriate to evaluate across basin lines by aquifer. An assessment of deeper aquifer systems will include the following:

- Mining of data in existing databases to determine contaminants in the aquifer
- Evaluating potential contaminants due to land use
- Evaluating pathways allowing contaminants to reach deeper aquifers
- Determining water quality using a selection of wells (private, public, or monitoring wells) for major cations and anions and other contaminants of concern
- Identifying fixed monitoring stations, including sentinel wells for water supply systems, for water quality and quantity
- Evaluating water use
- Delineating deep aquifer systems
- Making the data and assessment public

Phase III: Ambient monitoring network by basin and aquifer system
Wells useful for monitoring groundwater quality and quantity trends will be identified in phases 1 and 2. In phase 3 these wells will be sampled periodically for parameters specific to each basin or aquifer system. In addition, the wells will be available for use by other interested parties. Surface water monitoring stations will be monitored to determine trends reflected in groundwater/surface water interaction. Groundwater flow models will be updated as needed. Water use information will be a critical piece of information in determining water quantity trends. The data will be maintained by DNR and made available to the public.

Phase IV: Long term sustainability of monitoring network
The monitoring strategy must be flexible enough to reflect changes in water use, land use, and identified emerging contaminants. It is important to maintain fixed monitoring locations and to re-assess baseline evaluations periodically (every 5-10 years). The wells will be used to perform more detailed monitoring studies and serve as a basis for developing educational resources and reports. The data will be maintained in an accessible database.

Core and Supplemental Water Quality and Quantity Indicators

- Groundwater levels
- Groundwater flow
- Water usage
- Major anions and cations
- Nitrate
- Chloride
- Arsenic
- Radon
- Pesticides

Quality Assurance

See the description of DNR's Quality Management Plan (QMP) under the *Quality Assurance* section of the *Monitoring Program Logistics* Chapter in this document. Also see theBureau of Drinking Water & Groundwater Quality Assurance Project Plan (QAPP).

Data Management

A "Directory of Groundwater Databases" was completed by the GCC in 1998. This publication will be updated. It will form the foundation of a meta-database available on the Internet. Metadata refers to any data used to aid the identification, description and location of networked electronic resources. As the other components of the strategy are implemented, existing and new databases related to groundwater monitoring will be added to the meta-database.

One half of an FTE will collect and maintain the meta-database and be responsible for adding new databases as necessary. The Monitoring and Data Management subcommittee of the GCC will determine the minimum data elements and insure that data sharing occurs. The group recommends that the use of Wisconsin Unique Well Numbers be used as a means of tracking individual well data. The data will be available through a common portal, possibly located on the GCC website.

This component meets goals 1 and 2 by providing a mechanism for data sharing between agencies for groundwater characterizations and goal 3 by providing data to the public on groundwater in the state. We suggest that 0.5 FTE be funded within DNR to create and maintain the meta-database.

Data Analysis/Assessment

A comprehensive look at existing data for parameters of concern is a starting point for implementing each phase of the groundwater monitoring strategy. Existing databases (Groundwater Retrieval Network, DATCP, Wisconsin Groundwater Center and others) can be mined for parameters such as major anions and cations, nitrate, chloride, arsenic and radon. Public, private and monitoring well data and their databases will be assessed. This component could be done with the assistance of partners who currently maintain existing databases. The GCC joint solicitation is a possible funding source.

This component meets goals 1 and 2 by providing baseline data for groundwater trend analysis and system research. We suggest funding a 0.5 FTE for the initial assessment and subsequent data mining.

Reporting

Data and maps generated from monitoring data should be accessible. The Education Subcommittee of the GCC will determine how materials will be made available to all agencies and the public, and will act as a clearinghouse for educational materials posted on the GCC website. Creation and maintenance of maps and monitoring reports will require 0.5 FTE.

Programmatic Evaluation

The groundwater monitoring strategy was designed to be flexible. Wells sampled and what samples are analyzed for will change with changing priorities. The strategy allows for sampling of newly identified contaminants; abandonment, rehabilitation and installation of new monitoring wells if needed; and sampling of private wells for contaminants that state agencies are concerned about in a specific location. The data collected will be used to evaluate how well groundwater protection programs administered by different agencies are working. The data collected by the various agencies will be shared to make the most of funding available for groundwater monitoring.

General Support and Infrastructure Planning

The estimated cost for the new groundwater monitoring strategy is summarized in Table 12.

Table 12. Estimated cost of Groundwater Monitoring Strategy components.

Components	One Time Cost	Yearly Cost
Water Level Monitoring	$600,000	$120,000
Water Quality Monitoring (public, private and monitoring wells)		$180,000
Stream Flow Monitoring		Varied *
Modeling groundwater flow and surface water interactions		$90,000**
Data Management and Communication		0.5 FTE=$32,500
Data Analysis/Assessment		0.5 FTE=$32,000
Reporting		0.5 FTE=$32,500
Total	$600,000	$487,500

*The cost of adding one surface water-monitoring station to the existing network is approximately $10,000.00 per station. Additional stream flow measurements in small streams to supplement gauging stations will cost approximately $70,000 per year. To evaluate the environmental impact of high capacity wells under Wisconsin Act 310, stream flow measurements will be needed.
**This is based on a proposed cost of $90,000 for a 2-year project to model the Rock (Upper and Lower) Basin and assumes projects in two basins would be running concurrently. Project basins would be selected based on hydrogeologic and groundwater use factors. Not all basins would necessarily be modeled. It would take 5-10 years for coverage of all appropriate areas of the State.

Various groundwater monitoring programs are currently supported by state and federal agencies (see the Non-DNR Monitoring Programs section later in this document). Some of this data is suitable for inclusion in a common meta-database. An example would be DOT salt monitoring along highways. County health departments also currently sample private wells and that data may be included if appropriate. University research projects will be funded by grants with data made accessible through the GCC website.

Funding for the fixed networks would logically come from the programs they benefit. For example, federal Clean Water Act (106) and Nonpoint Source (319) grant money is allocated for monitoring. Fees collected, as part of the new Groundwater Quantity legislation will support money for water use data collection. Money allocated to the Groundwater Fund of the Environmental Fund will help fund some of the stratified random sampling programs as will money allocated to DATCP for pesticide monitoring. Safe Drinking Water funds could possibly be used to look at water quality and quantity trends at fixed stations placed to determine impacts to municipal wells. New funding sources may have to be found for the data mining, database development and maintenance and educational materials components.

Potential Partners
Potential partners include federal, state, and local governments, universities and other entities involved in groundwater management and research. In addition, volunteers (citizens, schools and others) will have opportunities for monitoring groundwater. Universities, high schools and private individuals might collect well samples. The WGNHS or USGS would provide well installation and training. This type of monitoring has been used in other states and meets both fixed monitoring and educational objectives.

References

Components of a Groundwater Monitoring Strategy for the State of Wisconsin. Wisconsin Department of Natural Resources. October 2004.

TIER 2: TARGETED EVALUATION MONITORING

Site-specific monitoring of targeted areas

Tier 2 provides a more comprehensive, short-term evaluation of individual waterbodies, often requiring cross-program collaboration. Waterbodies identified under Tier 1 as falling below designated minimum levels for the core indicators are prioritized and monitored more intensively under Tier 2. Under this tier, confirmation of the problem is made, along with documentation of the causes. This targeted monitoring may lead to the development of comprehensive management plans (e.g. TMDLs, etc.) for specific waterbodies. It also provides the pre-data for determining the resource's response to management measures that have been implemented (Tier 3). Monitoring in response to episodic events (e.g., fish kills), where the cause and extent of the problem must be determined, also falls under this tier, as do short-term, one-time studies, termed Special Projects.

TOTAL MAXIMUM DAILY LOADS (TMDL)

303(d) IMPAIRED WATERS LIST DEVELOPMENT[2]

Author: Jim Bauman

Status: Partially in Place

This monitoring is being done on a limited basis in some basins; however there is no systematic methodology currently in place.

Development of the biennial 303(d) list of impaired waters will be based on a number of other monitoring strategy components including ambient water chemistry, contaminated sediment, pathogen monitoring, volunteer monitoring and monitoring using biological metrics. On some waterbodies, the appropriate listing decision will be apparent after baseline sampling; others will require further investigation. This program targets further monitoring efforts on those waters that have been identified as likely to be impaired by other monitoring components or other agencies, but for which data is insufficient to determine actual impairment and the responsible pollutant(s) or sources. This monitoring component is explicitly created to ensure that monitoring is conducted on those lakes and streams that are highly likely to be impaired.

Monitoring Objectives

Clean Water Act Objectives

- Determining water quality standards attainment
- Identifying impaired waters
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific Objectives

- Identify whether suspected waters are in fact impaired and should be placed on the 303(d) list
- Identify the pollutant(s) of concern
- Support the development of TMDLs and management plans for impaired waters.

Monitoring Design

The waters to be monitored will be identified by the WDNR 303(d) list coordinator with consultation with Department regional staff. Between 40 and 50 waters will be identified annually with a limit of about 10 to 12 sites per DNR Region. Sampling design and frequency at each site will vary depending on site-specific circumstances. The targeted waters (or segments of waters) will be identified based on:

- Data collected from other agencies or educational-level volunteers that indicates a problem but does not meet QA/QC requirements for listing.
- Data collected where an insufficient number of samples were collected to meet that listing methodology. For example, based on a single sample collected through the baseline lake monitoring, spring sampling and monthly summer sampling would be needed.

[2] For purposes of this monitoring strategy component, impaired waters are meant to include threatened waters using EPA's definition of threatened as currently meeting water quality standards but the water quality is declining at a rate where water quality standards will not be met in two years (or a different period if the listing cycle is changed).

- Data collected by DNR staff that indicates an impairment, but insufficient information is available to determine the pollutant causing the impairment. (In some cases, the water may be included on the 303(d) list with the pollutant undetermined.)

WDNR staff are working on establishing a systematic, criteria-based process for 303(d) listing decisions, which will greatly facilitate this effort. It is anticipated that this process will be adopted into state administrative code by summer of 2007.

Core and Supplemental Water Quality Indicators

A variety of core and supplemental water quality indicators will be used to assess the 40 to 50 waters identified annually. Data from a number of statewide baseline monitoring efforts is used in the development of the statewide 303(d) list, including chemical analysis such as dissolved oxygen, temperature, pH, sediment, nutrients, metals, organic compounds (PCBs) and fish tissue (mercury contamination). Other specific indicators may be also be used given specific circumstances of individual waterbodies. It should be noted that the indicators to be used will be those that identify both impairments and pollutants causing the impairments. For example, for streams the core indicators will likely include measures of the condition of biological communities as well as measures that indicate the pollutant, such as nutrients.

Quality Assurance

All monitoring will be covered under the WDNR's Quality Assurance Plan (QMP). The specific section of the QMP depends on the specific indicators used.

Data Management

Data collected on these targeted waters will be entered into the SWMS datasystem, and will then flow to USEPA STORET. Monitoring sites will be geo-located based on the locational standards for the type of data collected.

Data Analysis/Assessment

Data will be analyzed or assessed based on the methodology used for the particular techniques and then compared to appropriate sections of the 303(d) list methodology. Assessment results will be included in the Waterbody Assessment Display and Reporting System (WADRS).

Reporting

Waters deemed impaired will be included in the next update of the 303(d) list. The information will also be entered into WADRS and will thus be included in the future Integrated Reporting (305b/303d) to USEPA starting in 2006. The results will also be included in the 303(d) list, which is available on the Department's 303(d) list website.

Programmatic Evaluation

The results of the monitoring will be reviewed as part of the process for updating Wisconsin's 303(d) list of impaired waters. The 303(d) list is subject to public review and EPA review and approval. As such, there will be three levels of programmatic review: Department review, public review and EPA review.

General Support and Infrastructure Planning

Staff and Training: Staff has been trained in the data collection techniques. About 640 hours in staff time is needed annually, based on 50 waters analyzed. The appropriateness of citizen involvement in these monitoring projects will be assessed on a case-by-case basis.
Laboratory Resources: The State Laboratory of Hygiene will conduct all water chemistry analysis.
Funding Needed: $16,000 to $25,000 for lab analysis plus costs for travel and supplies, based on 50 lakes and streams.

SOURCE IDENTIFICATION & LOAD ASSESSMENT

Author: Ken Schreiber

Status: Partially in Place

Currently this monitoring is only occurring in a few basins on a priority basis due to lack of funds. A systematic approach needs to be adopted and efforts need to be significantly increased to reach the EPA goal of 30 waters assessed per year.

Monitoring Objectives

The purpose of this monitoring is to provide supporting information in developing Total Daily Maximum Loads (TMDLs) for waters listed on the state's 303(d) impaired waters list. The range of impairments includes eutrophication, dissolved oxygen depletion, sedimentation, toxic substances and others. This monitoring component will support the implementation of Section 303 of the Clean Water Act.

Clean Water Act Objectives

- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific objectives

Specific objectives of this monitoring category are:

- Identify the extent and source(s) of pollutants that are causing the impairment(s).
- Quantify the total load of pollutants to a waterbody that are causing the impairment(s).
- Measure or estimate the relative contribution of pollutants from point and nonpoint sources in the watershed.
- Provide adequate information to develop water quality models appropriate for the waterbody and identified pollutant(s).
- Evaluate TMDLs during and after implementation. This monitoring will provide an assessment of the effectiveness of individual TMDLs.

Monitoring Design

The level of monitoring needed to accomplish these objectives is greatly dependent on the types and sources of impairments. Another major factor in designing a monitoring effort is the size and complexity of the watershed to be monitored. WDNR has developed technical guidance for monitoring and model selection for TMDL development (WDNR 2001). The guidance suggests using a three-tiered approach (simple, intermediate and complex) in determining the level of intensity and duration of monitoring for specific TMDLs. Monitoring strategies have been developed for each of the various types of impairments (i.e. nutrients, dissolved oxygen, sediments, etc.) and type of waterbody (lakes, streams, rivers, etc.).

Monitoring intensity may vary from grab water chemistry sampling of a lake or stream for a single growing season to fixed-station, continuous flow and bi-weekly water quality monitoring at multiple sites for 2-3 years. The level of effort and cost of monitoring for TMDLs will greatly depend on the duration and level of complexity of each project. Fixed-station continuous flow monitoring is typically contracted out to the U.S. Geological Survey (USGS) or U.S. Corps of Engineers (USCOE). No other Department monitoring effort currently provides the level of information necessary to develop site-specific TMDLs.

The Department anticipates initiating significant TMDL monitoring efforts an average of four locations per year, with varying levels of complexity. Funding for these projects is from 319 nonpoint source grants, so chosen sites must be nonpoint-dominated or focus on the nonpoint portion of a "blend" situation.

This monitoring category also includes monitoring the effectiveness of TMDL implementation in meeting established water quality goals. Monitoring may begin immediately after the TMDL has been established, or several years after implementation has been initiated. Generally, evaluation monitoring would replicate the initial water quality monitoring that was use to develop the TMDL.

Core and Supplemental Water Quality Indicators

Core water quality indicators are greatly dependent on the type of impairment that is being addressed by the specific TMDL. Chemical (nutrients, BOD, DO, various toxicants), biological (chlorophyll *a*, bacteria, etc.) and physical measurements (temperature, sediment) are the most commonly used indicators. For example a lake nutrient TMDL may include measurement of in-flowing nutrients, suspended solids and continuous streamflow, and in-lake parameters typically include nutrients (phosphorus and nitrogen), chlorophyll *a*, pH, secchi depth and DO/temperature profiles.

Supplemental indicators may include fish (population estimates, Index of Biological Integrity) aquatic insects (Biotic Index) and habitat assessments on streams where a use designation is being impaired. Additional indicators may include land use, cover type, soils, drainage system characteristics and climate data for land use modeling.

Quality Assurance

The TMDL monitoring plan design does not include a specific Quality Assurance Project Plan (QAPP) but rather relies on the Department's Quality Management Plan (QMP). Flow and pollutant loading data for primary TMDL monitoring sites is collected and quality checked by the USGS. Field sampling and analytical procedures follow established Department protocols in the WI DNR Field Procedures Manual (1998). The State Laboratory of Hygiene (SLOH) maintains its own quality assurance program for water chemistry analysis.

Data Management

Monitoring to develop TMDLs will be stored in SWMS beginning in 2005. Currently, chemistry data is stored in the SLOH data portal. This subset also flows to the DNR's STORET tables. Data collected at USGS monitoring sites is entered into the USGS water data management system; USGS collected data are readily accessible via the Internet and the USGS water data reports. Samples analyzed by the SLOH are entered within 2 months of analysis and the USGS data are entered into the data management system within 1 year of collection. All STORET sample collection sites are geo-located using WDNR location standards.

Field data is entered on lab sheets and into the SLOH database. Hard copy of field data is stored in staff files in the individual DNR regional offices.

Data Analysis/Assessment

Water quality data is used to develop and evaluate TMDLs. Typically, measured pollutant concentrations and continuous streamflow data is used in software programs (such as FLUX) to estimate daily and annual pollutant loads. These measured loads form the basis of developing a TMDL that will address the identified water quality impairments. Other water quality response models (such as WILMS and BATHTUB) are used to simulate the lake response of reductions in pollutant loads. The response models are used to identify a loading reduction level that will meet the identified water quality goal. Other models such as SLAMM and SWAT are used to estimate pollutant loads from various land uses. More discussion of model selection for developing TMDLs is provided in WDNR (2001).

Reporting

Monitoring results are presented as technical reports prepared by USGS, ACOE or WDNR staff, depending on funding or contracting arrangements. Water quality monitoring data is also summarized in each specific TMDL report. Draft and final TMDL reports are prepared by WDNR staff and made available to the public on the WDNR web site.

Programmatic Evaluation

Actual development of a TMDL generally provides its own feedback mechanism in that if the data is inadequate, the TMDL cannot be adequately determined. There are currently no ongoing programmatic methods used to evaluate the effectiveness of TMDLs.

General Support and Infrastructure Planning

The 2002 303(d) list included approximately 300 impaired waterbodies, not including those that are only impaired by Fish Consumption Advisories (FCAs) due to mercury and/or PCBs. The current level of funding and staffing to monitor and address these 300+ waterbodies over the next 10-15 years is woefully inadequate.

Staff & training – Few WDNR staff with the necessary professional training are available in the state to perform this work. Currently, one regional staff person and several Central Office staff are involved in some aspect of monitoring related to TMDLs. Much of the water quality monitoring has been contracted to outside agencies including USGS and the ACOE. Specific WDNR staff training to support monitoring and development of TMDLs is very limited and more is needed. Staff levels would need to be significantly increased to accelerate the development of TMDLs. The appropriateness of citizen involvement in these monitoring projects will be assessed on a case-by-case basis.
Laboratory resources – Currently, state funds to support laboratory resources for developing TMDLs are non-existent. Approximately 25% of the total cost of monitoring to develop TMDLs is needed for laboratory analysis.
Funding – The average cost of monitoring intermediate and complex TMDLs is estimated at about $25,000 each (some over multiple years). The total cost of monitoring all 303(d) waters to develop TMDLs (those that are not impaired by FCAs only) over the next 15 years is estimated at about $7.5 million (or $500,000 per year). A minimal effort would be to initiate monitoring for four TMDLs per year at an annual cost of about $100,000; this level of funding is currently in place through the 319 Incremental Grant. These funds are used to contract with outside agencies and provide lab and WDNR staff support.

Only one regional staff person and portions of several Central Office staff positions currently support this activity. Recent budget reductions have eliminated funds for lab and personnel support to develop TMDLs.

Program Gaps

Staff levels and available funding would need to be significantly increased to accelerate the development of TMDLs (see staffing and funding information in General Support & Infrastructure Planning, above).

References

Wis. Dept. of Natural Resources. 2001. WDNR Technical Guidance – Monitoring and Model Selection for TMDL Development. WDNR, Bureau of Watershed Management, Madison, WI.

Wis. Dept. of Natural Resources. 1998. WDNR Field Procedures Manual. WDNR. Madison, WI.

STREAM CLASSIFICATION USE ATTAINABILITY ANALYSIS

Author: Laura Bub

Status: Currently in Place

This program was established in the 1970s to meet EPA requirements. WDNR would now like to reevaluate and possibly redirect the program to be sure it is meeting the intended goals and to increase consistency across the state, perhaps necessitating increased staff. This program currently focuses on targeted sites with WPDES dischargers, but WDNR may be interested in shifting sampling to a more representative statewide coverage in the future if feasible.

Monitoring Objectives

Clean Water Act Objectives

- Establishing, reviewing and revising water quality standards
- Determining water quality standards attainment
- Identifying impaired waters
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific objectives

Objectives of the Use Attainability Analysis (UAA)/Stream Classification program are:

- Collect information on the water quality of Wisconsin waterbodies
- Appropriately designate use(s) of statewide waterbodies in order to accurately assign WPDES effluent limits
- Appropriately designate potential use of stream in order to protect water quality in compliance with the Clean Water Act.
- Monitor to assess water quality conditions in relation to nonpoint source management projects.
- Monitor water quality conditions to support the TMDL/303(d) program and the integrated 303(d)/305(b) Report.
- Determine correct Use Designations of Statewide waterbodies to be used in the construction of an accurate GIS layer of stream classifications.

Monitoring Design

Water bodies throughout Wisconsin are monitored on an as-needed basis to determine their stream classifications. However, all streams that have not yet been assessed are currently classified as warmwater fisheries by default. Reviews of classifications are completed on a priority basis, most often focused on streams with a WPDES permitted discharger discharging to the waterbody. Within this category of streams with permitted discharges, monitoring and assessment work is prioritized by activities such as WWTP facility planning/upgrade, 303(d) listing, waters with sensitive species (endangered/threatened), etc. At such time that staff and resources are available, efforts may be made to classify additional streams that do not have

associated WPDES dischargers. Some baseline monitoring-wadable stream data is used to supplement stream classification field data.

Core and Supplemental Water Quality Indicators

Core indicators of this program consist primarily of Fish and Aquatic Life parameters, including biological community condition (fish and macroinvertebrates), dissolved oxygen (DO), temperature, and flow. More extensive data is collected if necessary, often in order to clarify a classification or to answer a site-specific question.

- Fish community: assessed to gain an understanding of what fish species are found in a waterbody, and to aid in the decision process of assigning a use designation to a stream segment.
- Macroinvertebrate community: assessed when a robust fish population is not present in a waterbody (or often even when a robust community IS present). The types of macroinvertebrates found can indicate the quality of the water at a specific site.
- Habitat characteristics, including stream width, depth, and flow, are assessed to help in determining the *potential* aquatic community a surface water could support.
- Water quality assessments are conducted to determine possible characteristics that may be limiting aquatic populations, as well as to help determine the type of aquatic life that could be attained in a specific water body. Water quality parameters that are routinely collected are dissolved oxygen and temperature. Parameters such as suspended solids, ammonia and other toxic substances can also impact aquatic communities, and may be sampled as necessary.
- Additional assessments that may be conducted include, but are not limited to, sediment chemistry, ambient water chemistry, and effluent toxicity tests.

Quality Assurance

Chemical, biological and physical sampling/assessment, as well as analytical procedures follow established WDNR protocols.

Data Management

All data collected as part of a UAA / Stream Classification are considered public information and available for public review upon request. In 2005, the SWMS database will be available to hold current and future data. All UAA/Stream Classification datasets currently held on PCs and in paper files are a very high priority for data entry into SWMS.

Data collected for the purpose of doing a Use Attainability Analysis/Stream Classification are compiled into a written Use Designation Report. Reports are archived in WDNR Central Office files in Madison. Fish data are often entered into the WDNR FH database. Other analytical data are maintained in databases by the State Lab of Hygiene and UW-Stevens Point Aquatic Entomology Lab.

Data Analysis/Assessment

Data collected is analyzed collectively to determine the appropriate classification of surface waters. Fish data are utilized for the Index of Biotic Integrity (IBI) to evaluate the environmental quality of the water body. Macroinvertebrate data that is analyzed leads to a Hilsenhoff Biotic Index (HBI) value, which gives an idea of the pollution tolerance of the organisms found. Chemical, physical and biological data are analyzed according to the WDNR Field Procedures Manual and/or standard operating procedures at laboratories.

Guidance on how to interpret data in order to ultimately assign a use designation is found in the (DRAFT) Guidelines for Designating Fish and Aquatic Life Uses for Wisconsin Surface Waters, Wisconsin Department of Natural Resources, May 2004.

Reporting

Collected data are summarized in the form of a Stream Classification Report/Use Attainability Analysis. These data are referred to in 303(d)/305(b) Report as well as water quality plans for each water basin in Wisconsin. As needed, use designations are also promulgated in Chapter NR 104 of the Wisconsin Administrative Code.

Programmatic Evaluation

Redirection of this program has occurred as problems have arisen. However, staff would now like to undertake a more thorough evaluative process.

General Support and Infrastructure Planning

Staff & Training – There are currently about 30 DNR staff involved in Use Attainability Analyses/Stream Classification efforts. However, these staff members are not necessarily assigned exclusively to this task. In order to thoroughly and effectively carry out this task it would be useful to have additional staff assigned to this effort, potentially up to double the number that currently exist. Due to the addition of new staff members to this program who are not completely familiar with monitoring protocols, data assessment and report write up, training is absolutely vital to the success of this program. There is a strong need for training to address what type of fieldwork is necessary, as well as how those field samples should be collected. Furthermore, in order to improve statewide consistency in how collected data is analyzed and reported, there should be training on proper techniques for synthesizing field data and recommending an appropriate classification. Stream classification projects may provide a good opportunity for citizen involvement, and will be evaluated further.

Laboratory resources & Funding – Water samples collected from field surveys are sent to certified laboratories for analysis. In the UAA/Stream Classification program, macroinvertebrate samples are routinely collected, and samples are sent to University of Wisconsin-Stevens Point (UW-SP) for analysis. There is a charge of $115/sample for this analysis. Many regional staff have a backlog of archived samples to be analyzed by the UW-SP lab when time and money permit. There are also occasions when water chemistry samples are collected in order to substantiate a stream classification. These samples are typically sent to the State Laboratory of Hygiene for analysis. The cost for analysis varies according to sample type.

References

[DRAFT] Guidelines for Designating Fish and Aquatic Life Uses for Wisconsin Surface Waters, Wisconsin Department of Natural Resources, May 2004.

SPORT FISHERIES ASSESSMENT

WARMWATER/COLDWATER FISHERIES ASSESSMENT

Author: Tim Simonson

Status: Currently in Place

This program has been in place since the 1940s and has been consistently implemented using a variety of funding sources.

Assessments of sport fisheries are intensive site-specific surveys used to determine the cause and extent of problems with gamefish populations. Problems are typically identified during baseline monitoring surveys. Ideally, an integrated ecological assessment with several other monitoring programs should be conducted in order to pinpoint the reason(s) for the impaired status of the sport fishery.

Monitoring Objectives

Clean Water Act Objectives

- Identifying impaired waters
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific Objectives

- Identify extent of and causes for fishery impairments.
- Develop a management plan.
- Evaluate program effectiveness.

Monitoring Design

Intensive site-specific monitoring at targeted sites.

Core Indicators

- Population Abundance
- Length Frequency
- Age and Growth
- Recruitment
- Angler effort, catch, and harvest

Supplemental Indicators:

- Habitat conditions
- Water Quality conditions

Quality Assurance

Standardized protocols, training.

Data Management

Data are incorporated into the Fisheries and Habitat Statewide Database system with site descriptions and/or latitude/longitude, and are made available there via access to the World Wide Web.

Data Analysis/Assessment

Data from individual waters are compared to other similar waters in the FH Statewide Database and/or to data collected previously on that waterbody.

Reporting

Data may be reported in the following manners:

- SFR or Fish-SEG Progress Report
- Survey Report
- Management Plans
- Technical Reports

Programmatic Evaluation

The projects funded under this category are of two types. First, high-priority statewide monitoring needs are funded and coordinated by central office staff. Second, other local monitoring needs are funded on a competitive basis, with review and ranking done by a team of central office and region staff. The review team meets biannually to review the projects, develop the workplan, and ensure that it is meeting the needs of resource managers. Program reviews of workplan performance are completed regularly by the central office to evaluate job completion.

General Support and Infrastructure Planning

Staff & Training - Approximately 24 FTE participate in this monitoring activity. Volunteers may be considered to assist WDNR staff in the field with monitoring for this program.
Laboratory resources - None.
Funding - Funding for this activity comes from the Sport Fish Restoration account and Lake Sturgeon license sales at approximately $550,000 annually. Total estimated support, including permanent salaries, fringe benefits, and other indirect costs is approximately $1,600,000 annually.

TREATY ASSESSMENT

Authors: Dennis Scholl, Joe Hennessy, Tim Simonson

Status: Currently in Place

This program has been in place since the mid-1980s and has been consistently implemented using a variety of funding sources.

Assessments of joint sport-tribal fisheries in Wisconsin's ceded territory are intensive site-specific surveys used to determine the status of walleye and muskellunge populations and to set safe harvest levels. The fishery is monitored to ensure compliance with court-mandated harvest levels.

Monitoring Objectives

Clean Water Act Objectives

- Identifying impaired waters
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific Objectives

- Determine trends in the status of walleye and muskellunge populations in the ceded territory
- Ensure compliance with court-mandated exploitation levels (monitor program effectiveness)
- Set safe sport and tribal harvest levels (develop management plans)

Monitoring Design

Sampling is done on a stratified, random rotation of lakes within the ceded territory. A total of 12 to 27 lakes are sampled each year, depending on lake size. Lakes on the schedule are designated as either "spatial coverage" lakes or trend lakes. Spatial coverage lakes are sampled once each within a 12-year period. Sampling includes spring population estimates on walleye, muskellunge, and other gamefish, fall sampling of juvenile gamefish for recruitment information, and an angling creel survey throughout the open-water and ice-fishing seasons for gamefish species. The 12 trend lakes are sampled annually in the fall for gamefish recruitment, and receive a more comprehensive survey, including creel survey, every three years.

In addition to the sampling above, the baseline monitoring sampling elements are added to each lake on the schedule.

Core Indicators

- Population Abundance
- Length Frequency
- Age and Growth
- Recruitment
- Angler effort, catch, and harvest

Quality Assurance

Standardized protocols, training and dedicated field sampling crews.

Data Management

Data are incorporated into the Fisheries and Habitat Statewide Database system with site descriptions and/or latitude/longitude, and are made available there via access to the World Wide Web.

Data Analysis/Assessment

Data on angler and tribal exploitation are evaluated to ensure compliance with court-mandated levels. Population assessment data are used to set safe-harvest levels.

Reporting

Data are reported in the following manners:

- SFR or Fish-SEG Progress Report
- Survey Reports by individual fisheries biologists
- Management Plans
- Annual Report
- Mandatory data exchange with the Great Lakes Indian Fish and Wildlife Commission (GLIFWC)

Programmatic Evaluation

Program review is accomplished internally with meetings of the Treaty Fisheries Assessment Team, which meets twice each year, and jointly with the GLIFWC, which also meets 2 times each year.

General Support and Infrastructure Planning

Staff & Training - Approximately 14 FTE participate in this monitoring activity. Volunteers may be considered to assist WDNR staff in the field with monitoring for this program.
Laboratory resources - None.
Funding - Funding for this activity comes from the segregated account (Fish), Sport Fish Restoration, and Gaming revenues at approximately $407,000 annually. Total estimated support, including permanent salaries, fringe benefits, and other indirect costs is approximately $1,100,000 annually.

References

Hennessy, J. M. 2002. Wisconsin Department of Natural Resources 2001-2002 Ceded Territory Fishery Assessment Report. Administrative Report 55. Bureau of Fisheries Management and Habitat Protection, WDNR.

CONTAMINATED SEDIMENTS

Author: Greg Hill

Status: Partially in Place

Some monitoring of contaminated sediments is currently done on a limited basis. The WDNR has limited staff and funding available to conduct and manage a contaminated sediment site evaluation/assessment program. However, the Department has produced a number of guidance documents which describe a multi-tiered approach to site assessment. This approach is utilized for projects funded directly by the Department and for review of site investigations proposed by other entities. The program has moved forward more rapidly in the Great Lakes Basin waters because of the focus of federal and state resources to address impaired waters in the Areas of Concern in the Great Lakes.

Monitoring Objectives

Clean Water Act Objectives

- Determining water quality standards attainment
- Identifying impaired waters
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific Objectives

Within the limited resources that are available, the Department strives to:

- Establish monitoring protocols for sediment assessment.
- Assess sediments as a potential source of water quality impairment.
- Establish the presence of contaminants linked to the issuance of fish consumption advisories.
- Establish links to potential sources of the discharge of the contamination in order to identify responsible parties.
- Develop a basis for development of site specific water quality based sediment clean up standards.
- Establish protocols for determining the success of remediation actions.
- Coordinate with the baseline monitoring program when possible to achieve sampling efficiencies.

Monitoring Design

The Department has established a multi-tiered approach to sediment assessment. This approach is flexible in its application based on the amount of water quality and source information available. The statewide fish contaminant sampling program has historically identified a number of locations with contaminated fish but for which there are no current discharges of bio-accumulative contaminants. Similarly, or in concert with the fish contaminant monitoring, baseline ambient water quality assessments have turned up impaired waters with no known sources. The monitoring design for suspected contaminated sediment sites involves a team of individuals that focus on sediment chemistry, bioassay, and site delineation. Likewise, the sediment investigations are implemented in a coordinated fashion that can involve multiple programs and central office with regional staff. Bioassay work is conducted by the Wisconsin State Lab of Hygiene.

Core and Supplemental Water Quality Indicators

Due to the dynamic nature of streams, there are no specific core indicators for the sediment monitoring program. The sampling tends to be investigative in nature triggered by water quality impairments such as elevated levels of fish tissue contamination or in concert with upland site investigations. Grab samples for surficial sediments or core samples for a longer-term record are used. To date bio-accumulative substance such as PCBs, DDT, and mercury as well as PAH (polyaromatic hydrocarbons) have most frequently been the focus. However in other instances other contaminants such as ammonia and arsenic have been evaluated.

Quality Assurance

It is standard operating procedure to develop a quality assurance and sampling and analysis plan for the site investigations prior to initiating the study. The State Lab of Hygiene is our reference lab for the state and all private labs must be certified by the state in order to produce acceptable results.

Data Management

The Department maintains the statewide data in the Fish-Sediment Contaminant Database. Due to the nature of the program where potentially responsible parties are identified to assume the site specific work, additional site-specific databases are maintained. When the more comprehensive SWMS database is completed, contaminated sediment data will be stored there.

Data Analysis/Assessment

The sediment assessment data is analyzed in a coordinated and integrated fashion in order to assess the risk associated with the site, determine appropriate responses, solicit voluntary or enforcement-based response actions by responsible parties or conduct the remedial actions ourselves, and document remediation success. The WDNR has produced guidance for the use and analysis of sediment site data entitled "Consensus-based Sediment Quality Guidelines."

Reporting

The WDNR has created a Contaminated Sediment Team with cross-program representatives who coordinate site assessment procedures and maintain a sediment site inventory for the state. The Department has used this inventory in a number of ways including the development of the 303(d) list of impaired waters and in the preparation of the 305(b) Water Quality Report to Congress. In the future these will be integrated into a joint 303(d)/305(b) Report. The listing will also be used for site tracking and work planning in the future.

Programmatic Evaluation

The contaminated sediment program will be managed under the Sediment Management Section in the Bureau of Watershed Management. It is anticipated that this program sub-element will be reviewed on the same cycle as the remaining portion of the water management program.

General Support and Infrastructure Planning

As part of the initial work efforts conducted by the new Sediment Management Section, the Department will assess the needs for program administration.

ENFORCEMENT, SPILLS & KILLS MONITORING SUPPORT

Author: Paul LaLiberte

Status: Currently in Place

This program has been in place since the inception of the agency. Lab samples are supported by a portion of the Basic Agreement with the SLOH, but staff time investment comes at the expense of work planned projects.

Monitoring Objectives

Clean Water Act Objectives

- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific Objectives

Enforcement - WDNR enforcement programs frequently are more effective when they include information about the effect of the permit violation on waters of the state. This most often involves specific WPDES permits but can also include general WPDES permits, Chapter 30 Permits, DNR landfill licenses, groundwater remediation or other regulatory programs with WDNR involvement. The objective of this monitoring is to provide staff pursuing enforcement actions with environmental data that strengthens the case and often influences the amount of penalties.

Spills & Kills - WDNR staff are frequently called on to investigate pollutant spills and fish kills. These investigations sometimes identify a pollutant source in need of control or enforcement action. Other times, they document instances of natural mortality, such as fish disease outbreaks. Usually, some kind of monitoring is involved. The objective of the monitoring is to determine the cause of a kill event or the consequences of a spill event.

Monitoring Design

The design of these monitoring efforts are very case-specific and usually developed with relatively short notice in response to an evolving enforcement case, spill event or fish kill report.

Core and Supplemental Water Quality Indicators

Water chemistry (BOD, DO, various toxicants) and physical measurements (temperature, sediment deposition, etc) are the most commonly used indicators. However, sampling of fish or invertebrate populations is sometimes appropriate as well. A count of dead fish by species is sometimes incorporated into determination of penalties. Collection of fish in distress or fresh/dead fish can be part of fish kill investigation.

Quality Assurance

Sampling and analytical procedures follow established Department protocols. In addition, this type of monitoring typically includes chain of custody procedures to ensure admissibility of data into legal proceedings.

Data Management

Electronic data from this type of monitoring follows the path of other, more routine sampling: water chemistry into SLOH system, invertebrates into the UW Stevens Point database, fish data into the USGS Fish and Habitat database where baseline protocols are employed. File data and voucher samples are sometimes kept temporarily in separate, locked facilities until the enforcement case is resolved.

Data Analysis/Assessment

With the understanding that the conclusions of the analysis will likely be disputed, special care is usually given to collecting additional supporting data and enlisting additional individuals with specialized training to evaluate the results. This may mean replicate sampling where statistical applications are required.

Reporting

Monitoring results are introduced in report format as an exhibit, or as professional testimony. A database for reporting and tracking fish kill investigations has been developed by the FH Bureau.

Programmatic Evaluation

Programmatic evaluations likely to reflect these activities are annual summaries on fish kills investigated, enforcement actions, enforcement success rate and penalties recovered.

General Support and Infrastructure Planning

Staff & training – WDNR staff with the necessary professional skills to perform this work are decentralized around the state and in position to perform the work. There are approximately 2-3 persons in each of the 22 WDNR basin service areas capable of providing at least a portion of this kind of expertise. In FY03 the FH Bureau committed 820 staff hours to this effort and the WT Bureau committed 1475 hours. This does not include all the time spent responding to manure spills, which is sometimes coded to another account. It is anticipated that these figures are average annual amounts. Currently, staff time spent responding to enforcement issues requires a workplan modification; if time were allocated at the beginning of the year (perhaps based on previous years' time codes) less time would be pulled away from other jobs. Specific training on monitoring in support of enforcement actions and spill/kill investigation is limited and occurs at an inadequate frequency to support new hires. More is needed.

Laboratory resources – Adequate chemical analytical capacity exists at SLOH to perform this work ($25,000 annually in the Basic Agreement). However, the centralized nature of the lab creates problems for enforcement samples with very short holding times (6 hours for bacteria). A limited capability to have invertebrate samples analyzed also exists. Toxicity testing in a centralized facility (SLOH) is available and lab staff are usually able to respond to short term emergency sampling. A fish disease specialist with the FH Bureau in Madison is available for consultation on these cases.

Funding – No specific staff resources or time allotments are dedicated to this activity. Since this is probably the highest priority monitoring work, any activity in this area comes at the expense of other planned actions. Where extremely complicated and involved enforcement cases develop, this creates a workload management problem. Since this work is infrequent and impossible to predict far in advance, it is hard to avoid this problem. To the extent that routine monitoring resources are reduced, capability to perform this work is similarly diminished. In FY03 $1100 of expense funds were committed to this effort by the WT Bureau. It is hard to tell the amount of expense funds contributed by the FH Bureau since this account seems to be a catch-all for multiple activities, primarily supporting the fish disease specialist.

SPECIAL PROJECTS & RESEARCH

Author: Paul LaLiberte

Status: Partially in Place

This monitoring is conducted as special projects. FH is set up to receive and rank special projects during the work planning process; a similar process for WT is needed. Resources would need to be allocated to support special projects monitoring.

Monitoring Objectives

Clean Water Act Objectives

- Establishing, reviewing and revising water quality standards
- Determining water quality standards attainment
- Identifying impaired waters
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific Objectives

This monitoring occurs as a result of potential problems identified from a variety of sources. The objective of the monitoring is to investigate a potential problem and determine if special management should be pursued through inter-governmental or industry cooperation or even special legislation. Most often these issues are site specific, but can be statewide in nature. Monitoring of invasive species formerly fit into this category before the effort obtained its own program and budget.

Examples of past monitoring developed to meet site-specific needs include:

- Dam operations – Monitoring to document the effects of tailwater or headwater fluctuations, the thermal or water quality effect of top draw versus bottom draw and assessment of dam removal options.
- Thermal effects of urban land use on coldwater resources.
- Compliance monitoring of WPDES permitted wastewater facilities.
- Impact of failing septic systems or other sanitary system deficiencies on adjacent water bodies.
- Impact of industrial groundwater withdrawal on adjacent waterbodies.
- Investigation of newly discovered blue green algae with significant public health implications; investigation of algal toxicity via mouse assay.

Examples of proposed Special Projects and Research currently under consideration include:

- *Nutrients in Nearshore Waters of the Great Lakes*

  The objectives for nearshore monitoring of the Great Lakes are to determine trends in nutrient concentrations and water clarity and provide information for nearshore management issues. Specifically, this program would help monitor impacts of nutrient loading from Great Lakes tributaries and impacts on nearshore environment, and identify problem areas for alga blooms along the coastlines. The presence and absence of *Cladophora* and zebra mussels will be included in the monitoring protocol to supplement information on nutrient trends. One initial sampling season was

done in 2004 to test monitoring design and protocols. Additional funding will be needed to continue this program.

- *Effluent Limit Refinement for Use Attainability Analysis*
  Data were compiled in a 2004 report that indicated that a strategic, widespread evaluation of the categorical effluent limits established in the 1970s is warranted to determine whether assumptions based on earlier technologies are still valid or whether an overhaul of these limits is needed. Preliminary investigations in a limited geographic area have shown the potential for this effort to substantially advance the state's efforts to revise and update NR104 and correct inappropriate assumptions. To ensure that these professional judgement based effluent limits are adequately protective, while not being overly protective, monitoring is needed. The monitoring would be focused at sites and times when stream flow was dominated by wastewater effluent, at locations across different ecoregions of the state.
- *Lake Superior Tributary Monitoring for Suspended Solids and Flow*
  Monitoring is needed to quantify the effects of various erosion control practices on tributaries to Lake Superior. This would involve looking at recovery rates of spawning areas affected by the various practices, and evaluating load reductions of solids transport under various flow conditions to evaluate effectiveness of BMPs in the watershed. Monitoring would occur over a 5-8 year period to measure changes resulting from the various practices used to control erosion. Because there are currently no standard techniques to use for these types of evaluations, appropriate techniques and sampling schedules would need to be developed.

Monitoring Design

Project proposals will need to be developed by regional staff to receive laboratory support under this category. The design of these monitoring efforts will be very site-specific. In most cases, the problems have been in existence for some time so that the work can be incorporated into monitoring work plans. Exceptions include problems with significant public health implications where incorporation into a biennial work plan cycle is inappropriate. These problems can have sufficient public/political interest as to displace other planned work. While it may be possible to postpone the monitoring until it can be incorporated into work plans, it is often not possible to avoid it altogether with the claim that it does not pertain to our EPA grant supported, regulatory work. Failure to acknowledge the need for this monitoring sometimes results in resources being diverted from monitoring planned in support of regulatory programs.

Core and Supplemental Water Quality Indicators

These activities range from standard water chemistry and physical measurements to methods under development such as algal toxin assays. Long term recording (months) of water level, temperature, etc. may be involved. Sampling of fish or invertebrate populations is sometimes appropriate as well.

Quality Assurance

Chemical and biological sampling and analytical procedures follow established Department protocols. The long term recording methods have not been standardized and this remains a program need.

Data Management

Electronic data from this type of monitoring follows the path of other, more routine sampling: water chemistry into SLOH system, invertebrates into the UW Stevens Point database, fish data into the FH data base where baseline protocols are employed. Data from long term recording units do not have a standardized data management form and this remains a program need. It is anticipated that SWMS will be a repository for data collected through this program.

Data Analysis/Assessment

Due to the wide open nature of this category of monitoring, it is not possible to generalize data analysis techniques.

Reporting

Reporting will occur in a variety of formats, including technical reports and public presentations /news releases. It is possible some of these investigations will result in an impairment listing under 303(d), and be reported in the integrated 303(d)/305(b) Report.

Programmatic Evaluation

Since these activities are not part of EPA grant supported programs they tend to be viewed as departures from program expectations. They commonly appear in program evaluations as justifications as to why EPA grant supported work did not get done.

General Support and Infrastructure Planning

Staff & training – Since the monitoring needed to address the diversity of issues that come up in this category can be quite specialized, local Department staff can be unaware of appropriate methods. The best way to deal with this is establishment of a forum of exchange of technical information. This formerly was partially satisfied by statewide program meetings and regular meetings of staff involved in monitoring. As budgets have caused these meetings to become less frequent, staff have become less aware of monitoring options beyond the techniques used in regular, EPA grant-supported monitoring. Also, the distribution of staff with the specialized knowledge to conduct this monitoring is not uniform and cooperation across basin and regional lines is needed. This does not always happen. The current work planning system makes it difficult to estimate how much of this kind of work occurs. However, given the fact that this monitoring is compelled to happen despite not being an integral component of EPA grant funded activities, it seems prudent to set aside some resources to acknowledge the unavoidable need to do the work. It is suggested that monitoring hours to support basic Clean Water Act programs be increased 5-10% to accommodate the need to do this work. Volunteers may be considered to assist with special projects on a case-by-case basis.
Laboratory resources – $40,000 of laboratory services has been allocated to this category for water quality analysis for streams special projects. No funds exist to analyze invertebrate samples under this category.
Funding – No specific staff resources or travel funds are dedicated to this activity. As a result any activity in this area will be at the expense of other planned actions where public/political pressure prevails over program direction. It is suggested that monitoring expenses to support basic Clean Water Act programs be increased 5-10% to accommodate the need to do this work.

TIER 3
MANAGEMENT EFFECTIVENESS & COMPLIANCE MONITORING

Determining effectiveness of management measures & permit conditions

Tier 3 monitoring provides follow-up analysis of management plans that have been implemented for problem waterbodies, and evaluates permit compliance and the effectiveness of permit conditions. Monitoring under this tier evaluates the responses of core indicators from Tier 1 and 2 to management actions. Effectiveness of waterbody-specific management actions is determined using core indicators from the more intensive sampling designs under Tier 2 that are specific to the problem being addressed. The chosen indicators are compared before and after management actions are implemented.

Regulatory monitoring of permitted entities is also included in this category. Effluent monitoring helps WDNR determine whether permitted entities are meeting their permit conditions and state regulations. This type of monitoring is often done through self-reporting by the permitted entities, combined with spot-checks by WDNR staff. Monitoring of receiving waters assesses what the effect of an effluent is on the water quality in the receiving waterbody. This monitoring helps determine whether current effluent limits are appropriate or should be altered. Monitoring of public drinking water wells is carried out to ensure that surface and groundwater meet federal public health standards for contaminants in drinking water.

NON-POINT SOURCE PERFORMANCE STANDARDS & PROHIBITIONS

Authors: Mary Anne Lowndes, Carol Holden

Status: Various Projects in Place

These evaluative projects are designed individually to address specific management questions. Several special projects have been undertaken to evaluate urban and agricultural Best Management Practices (BMPs).

Monitoring Objectives

The use of performance standards and prohibitions to control polluted runoff in Wisconsin went into effect Oct. 1, 2002. Statewide performance standards were developed for both agricultural and urban land use activities along with four prohibitions targeted at manure management. Monitoring objectives associated with attainment of performance standards and adherence to manure management prohibitions are listed below. These objectives move along a continuum from administrative tracking to long-term water quality outcomes.

Clean Water Act Objectives

- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific Objectives

- Track compliance with agricultural and non-agricultural performance standards and prohibitions.
  - Track preparation of erosion control and stormwater plans for new development
  - Track location and types of stormwater control practices for both new development and retrofits
  - Track participation by rural landowners and governmental entities (and compliance levels where appropriate)
  - Track costs of urban and rural control practices for lakes and streams
- Improve our ability to select and design nonpoint source control practices.
  - Test the effectiveness of selected urban BMPs and work with the UW on agricultural control practices
  - Improve our information on the cost of installing and maintaining all types of control practices
  - Develop sizing criteria for selected stormwater control practices.
  - Enhance urban runoff models to include the ability to design most commonly used stormwater practices
  - Develop technical standards to help implement both agricultural and non-agricultural control practices
- Determine the critical sources of nonpoint source pollutants.
  - Complete source area monitoring for urban areas
- Determine the ability of the performance standards and prohibitions to achieve the beneficial uses of our rivers, lakes and streams.
  - Determine whether current Best Management Practices are effective at achieving improvements
  - Calibrate and verify models used in planning and implementation of performance standards
  - Determine what changes to our management measures, programs, projects and tools need to be made or which tools need to be developed
- Improve our knowledge of the pollutants or factors impairing the beneficial uses of Wisconsin surface waters and set new levels of performance standards.

Monitoring Design

Most nonpoint management evaluations are developed for individual situations, thereby making each project unique in its design. Researchers might coordinate with existing monitoring schedules for fixed station, targeted, and baseline or ambient monitoring for lakes and streams, or might pursue separate monitoring schedules that best fit project needs. Before-and-after designs often use the same monitoring methods as were used in previous Tier 2 TMDL monitoring to provide results that can be directly compared. Addition of nutrient and bacteria parameters to baseline monitoring would help support nonpoint management research.

Whole stream monitoring (before and after BMP monitoring) is being conducted in selected priority watersheds where BMPs have been installed on a widespread scale. Monitoring is done before, during, and after practices are implemented, for a total of 10-15 years. For biological indicators, a Before-After Control Indicator (BACI) experimental design is used, which compares test sites with control sites where BMPs were not installed (control sites were not used for chemical parameters). Completion of the whole stream monitoring project is expected in 2007.

Agricultural

The designs for measuring status/participation/compliance will vary depending on the performance standard or prohibition, and will likely be a combination of judgmental design and model output to establish baseline measurements and rate of compliance. Examples of agricultural non-point Tier 3 projects that are underway include the following:

- The status of the cropland erosion performance standard at the field level will be a measure of the number of acres of cropland that meet the tolerable rate of soil loss (T) as calculated using the Revised Universal Soil Loss Equation (RUSLE 2). A statewide status evaluation is expected to be conducted by NRCS and DATCP using a statistically-sampled Transect Survey. The status of livestock-related performance standards and prohibitions, including nutrient management, will be measured through status reviews of conservation plans and nutrient management plans, followed by site inspections. The basic components are in place, but training and guidance will be needed to ensure consistent tracking and reporting.
- UW Madison is conducting monitoring on several Discovery Farms to determine the effects of certain agricultural BMPs and to develop specifications and criteria for future performance standards. Projects will be undertaken to investigate the water quality effects and cost-benefits of BMPs implemented under various management scenarios. Special projects, such as development and calibration of a WI phosphorus-loss risk index, will be conducted on these farms. Operators of three participating farms were trained to collect high-quality data and one is monitoring on an every-other week basis as planned. These data will provide a good baseline on which to build with more intensive monitoring at each farm in future years. Since its inception, Discovery Farm projects have been funded, in part, by the WDNR. However, now that the program is self-sustaining, it may be shifting to other funding sources.
- The Department is conducting a study to evaluate the influences of riparian buffer size and composition on the stream habitat, fishes, and macroinvertebrates. The Natural Resources Board has requested results from the buffer research projects by December 31, 2005 as a step in the development of buffer requirements. Although vegetative buffer strips have long been promoted as a BMP to curb stream degradation, we need to improve our understanding of how buffer extent and width influence stream conditions across the breadth of stream types that appear in Wisconsin. Instream habitat and biota data from about 90 streams will be employed to characterize effective riparian buffers.
- Measuring pollutant loads could involve collecting samples at the edge of fields and analyzing for pollutants of concern. This type of monitoring would likely by conducted by the UW and would require some coordination from Watershed Management staff. Another approach would be the use of formulas or models, but none of these have been identified for this activity.

Urban

When opportunity arises, two primary methods are used to study urban BMP effectiveness: source area loading and single-source monitoring of specific BMPs. Monitoring of source area loading measures the levels of pollutants delivered from untreated individual source areas (driveways, roofs, lawns, etc.) where no BMPs are applied. The BMP-specific monitoring and source area loading monitoring are part of an overall plan to identify the sources of pollution and the effectiveness of corrective measures. This type of monitoring is usually conducted above and below an installed BMP. BMPs that the WDNR has tested (or is in the process of testing) include street sweepers, rain gardens, low impact development techniques, infiltration devices, detention ponds, proprietary devices (such as Stormceptor and Vortechnics). Proprietary devices are monitored using EPA's Environmental Technology Verification (ETV) protocol. Information gathered is used to calibrate models such as SLAMM and P8, pollutant loading and reduction models for urban areas.

Core and Supplemental Water Quality Indicators

For long-term impact analysis, biological parameters are the least expensive means to address the effects of nonpoint pollution on the water resources. Baseline monitoring covers in-stream monitoring of biological parameters such as fish, macro-invertebrates and habitat and is conducted by regional biologists. Supplemental parameters such as sediment, nutrients, bacteria or toxics may also be measured during baseline sampling to support specific nonpoint projects.

Agricultural Core Indicators

- Total suspended solids
- Total phosphorus
- Dissolved phosphorus
- Bacteria (E. coli)
- Temperature
- Flow
- Dissolved oxygen
- BOD

Agricultural Supplemental Indicators

- Nitrite
- Nitrate
- TKN
- In-stream habitat

Urban Core Indicators

- Flow/Volume
- Total suspended solids
- Suspended solids concentration
- Dissolved phosphorus
- Total phosphorus

Urban Supplemental Indicators

- Toxics (PAH, pesticides, etc.)

Quality Assurance

The WDNR has a quality management plan (QMP) and an Evaluation System manual code (MC 9314.1) in place that establishes processes and protocols that the state's monitoring program must meet. While there are several Quality Assurance Project Plans (QAPPs) developed for ongoing projects and several more are currently being developed, the current QMP does not provide specific guidance for these performance standards because it was written before the standards were developed. Under the current EnPPA, the QMP is scheduled for review and revision by 6/30/2005. As nonpoint source elements are developed or further refined for the water monitoring strategy, additional quality assurance processes and protocols may need to be developed if the QMP does not adequately address them.

Data Management

Water quality field data can be stored in SWMS; assessment and field comments, indicated sources, impariments and pollutants can be held in WADRS. As the WADRS project evolves, WDNR will explore the options for building modules for nonpoint source data. Additional staff and funding will be needed for

this effort. Other databases, such as the Fish and Habitat database, are used as applicable. The whole stream monitoring and site specific monitoring results are published in USGS publications, since much of the work is contracted with USGS. These are available to the public through USGS or the department.

Agricultural
An NRCS database is being developed and tested in 2004 to collect county tracking data on the status of the performance standards and prohibitions. Staff from various agencies are trying to address the challenge of collecting relevant geo-spatial data in the face of varying county computer capabilities and staff shortages. If the Watershed Bureau decides to collect pollutant load data, data management procedures will need to be identified and developed.

Urban
Information about the stormwater permit program and the construction, industrial and municipal facilities covered by general or individual permits is available in the STORM and SWAMP systems. This is an Oracle database which stores detailed information about a facility's location and their compliance with permit conditions. The performance standards have been incorporated into the stormwater permits although the current database doesn't have specific fields to track compliance with a performance standard. SWAMP is only used with municipal permits to provide additional document storage that the STORM system cannot provide. Funding may be available to upgrade the database to make SWAMP and STORM consistent and available to current users of STORM. Regional and central office staff in the stormwater program have access to and input data into the STORM system. This database is not available to the public. These systems are used for daily administration of the stormwater program and for billing purposes. This system can track compliance with the permitting program, but will not track pollutant load reductions or in-stream water quality data. This data can be held in SWMS in the future.

Data Analysis/Assessment

Data on status of the performance standards and prohibitions will be collected and analyzed annually. Data collected as part of the whole stream monitoring or single source monitoring are used to calibrate models and set goals. The performance standards were a direct result of past monitoring efforts. This data is analyzed and reported in publications as informational pieces for the state and the public. This information is needed to assess whether a practice alone or in a treatment train with other practices can achieve the performance standards. Source area monitoring is necessary to predict end-of-pipe pollutant loads. This data is eventually included in model upgrades, a tool available to the public for estimating pollutant load reductions.

Reporting

Data on status of the performance standards and prohibitions is reported as part of the joint DNR/DATCP annual report to the Land and Water Conservation Board. Research results may also be used for the integrated 303(d)/305(b) Report, 319 reports to EPA, and for listing/delisting waters under 303(d).

USGS publications report the pollutant loading and reduction as a geometric mean concentration over a series of storm events for source area monitoring and measurement of BMP effectiveness. One to two seasons of data are included in the studies, which covers 15 or more storms. Specialized monitoring equipment was needed to collect surface runoff from source areas such as lawns, roads and roofs. These techniques are reported in trade journals and in publications within the state. Their availability is advertised on the USGS website.

Programmatic Evaluation

Data to measure progress toward meeting the performance standards and prohibitions will be collected annually to summarize compliance statewide (e.g., number of cropland acres in the state in compliance with performance standards, number of manure storage units meeting compliance standards, number of acres under nutrient management plans, etc.). Much of the data tracking will be done by counties and permitted municipalities, and reported to WDNR for evaluation. A process and timeline to evaluate the data has not yet been determined.

The public has a need to know which practices can achieve the performance standards. To this end, the state is providing technical standards for BMPs and monitoring results for proprietary devices and making them available on the WDNR website. Feedback from the public provides direction to the department on which BMPs to evaluate and which technical standards to develop. The technical standard development process is an opportunity to provide the detail that may be needed to implement a performance standard. The general language of the performance standard allows maximum flexibility, but minimum direction. The technical standards provide direction if the public chooses to use them. The technical standards, by their nature, can be adapted as needed to changing situations and public feedback.

General Support and Infrastructure Planning

Staff and training – 2 WDNR FTE and 4 LTE in Integrated Science Services spend significant time on nonpoint monitoring projects. Seven USGS staff and approximately three students also contribute time to these projects, and WDNR usually supports two University of Wisconsin Madison students. Nonpoint monitoring could provide excellent opportunities for citizen monitoring, and volunteers will be considered for specific projects on a case-by-case basis.
Laboratory resources – Approximately $120,000 annually is used toward laboratory analysis at the State Lab of Hygiene.
Funding – Approximately $547,000 is allocated to fund nonpoint source monitoring. Of this, approximately $451,000 is received through 319 grants, and approximately $96,000 is allocated from nonpoint source segregated funds. Significant funding also comes from outside sources such as municipalities (~$80,000) and Wisconsin Department of Transportation (~$70,000). Some additional funding needs are listed under *Program Gaps* below.

Program Gaps

- Baseline monitoring is provided across the state in locations determined by the regional biologists. For this information to be beneficial to the nonpoint program, collection of land use information including practice installation in the basins tested would enhance the predictive nature of this information. Baseline monitoring could be conducted in a watershed where no practices have been implemented as a background condition and then conducted later in watersheds where implementation of the performance standards has been broadly successful. Data from the monitoring under these conditions will provide answers and direction for the program in setting future goals. County and municipal staff has information on land use and could provide this information in same cases as a GIS layer. To meet this goal, the department would need to set as a priority the availability of land use data and BMP installation when identifying sites to monitor.

- A second area of concern is collecting information on source areas. Many source areas have been monitored, but to provide a thorough mass balance of a watershed, many more source areas need to be evaluated. A strategy of monitoring six different types of source areas per year for three years (18 total source area types) would provide the state with a relatively complete array of sources and predicted pollutant loads. This information will be used to improve the existing urban models. The cost of this effort would be $30,000 per source area, with USGS providing the staff under contract to the department.

- A third limitation has been the closure of existing stream gaging stations. Flow measurement is necessary to determine whether the infiltration performance standard has resulted in volume reduction. Stream gaging stations have been taken out of service recently to save the $4,000 annual maintenance fee. These stations are clearly needed to provide long term tracking of the hydrology of the watershed. Implementation of BMPs, without the flow data, limits the state's ability to predict the effectiveness of the current infiltration performance standard and whether the goal should be modified. The performance standards are applied statewide, but there is an interest in providing targeted performance standards where additional control is needed. Restoring stream gaging stations in critical ecosystems

would be the first step to providing the information needed to set site specific "targeted" performance standards.

- A fourth concern is the challenge of coordinating monitoring among various federal and state agencies that have multiple monitoring objectives, including ability to share data collected under different systems. WDNR has limited ability to influence how data is tracked and reported if it is collected by other agencies.

- A fifth concern is the need to continue monitoring to evaluate the effectiveness of different types of BMPs in urban areas. Monitoring must include all the types of unit processes that are available for urban BMPs (e.g., sedimentation, filtration, floculation).

POINT SOURCE EFFLUENT & RECEIVING WATER MONITORING

POINT SOURCE COMPLIANCE – CHEMICAL LEVELS IN EFFLUENTS

Author: Duane Schuettpelz

Status: Currently in Place

Targeted compliance monitoring for WPDES permittees has been in place since the beginning of the WPDES permitting program and is conducted as need arises. As staff conduct compliance monitoring and inspections they determine on a case-specific basis whether samples are necessary. This monitoring is covered under 106 funds from EPA as well as GPR and segregated funds covering staff time. There is currently a basic agreement with the State Lab of Hygiene to fund this sampling.

Monitoring Objectives

Clean Water Act Objectives

- Determining water quality standards attainment
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific Objectives

- Monitor wastewater effluent or other discharge waste streams and/or groundwater monitoring wells for compliance with permit limits
- Monitor effluent or other discharge waste streams and or groundwater monitoring wells to evaluate the precision and accuracy of data submitted by permittees

Monitoring Design

The WPDES program for traditional industrial and Publicly Owned Treatment Works (POTW) sources is based significantly on self-monitoring data which is collected and analyzed by permitted facilities and reported to the WDNR. WDNR is responsible for (1) evaluating this information for compliance with permit terms and conditions and (2) assuring the data is accurate and representative of effluent or discharge quality. The protocol for this component varies depending on the specific situation, with the primary purpose to evaluate the permittee's sampling and analytical methodologies. Examples include:

- Split samples from permittee's sampling equipment
- Grab samples of effluent or other waste streams
- Composite samples collected using DNR composite samplers
- Groundwater samples collected from monitoring wells
- Whole effluent toxicity monitoring

In all instances, compliance monitoring serves as a cross-check for laboratory analysis to assess laboratory QA/QC.

Core and Supplemental Water Quality Indicators

Permit compliance monitoring is intended only to be a direct measurement of compliance with limits in WPDES permits. Bacterial sampling for measuring success of disinfection or whole effluent toxicity testing are primarily indicators of potential health risks or toxicity concerns for aquatic life, respectively. However, permit compliance is based upon the direct measurement of the noted parameters.

Quality Assurance

This activity is covered under the Department's general Quality Management Plan and the WPDES program's inspection strategy (see references)

Data Management

The data collected are intended to be included in the SWAMP system data base. The data are accessible only to staff who have access to the information in the SWAMP system. To relieve this problem, in the future, outfall monitoring data will also have an associated monitoring station and thus this data would be available via SWMS or SWAMP using this unique identifier.

Data Analysis/Assessment

Data collected within this element is primarily used only for site-specific or incident-specific decision-making. Because the information is primarily intended to capture a given moment, there is no appropriate statistical or other analysis for the information that is collected. If data is collected over a period of time, simple averages (e.g., weekly, monthly, etc.) may be used in assessing compliance with permit limitations.

Reporting

Data from this sampling is stored in the permit files and is used is assessing compliance, providing data for potential enforcement actions, and developing permit reissuance requirements. Data is available to the public through open records requests.

Programmatic Evaluation

No evaluation program has been developed for this monitoring component.

General Support and Infrastructure Planning

Staff and Training - Approximately 100 FTE are currently involved in the WPDES program in some way. Because of program responsibilities, only about one-half of this number may potentially conduct monitoring under this program component. There is no formal training program for staff in the collection of samples for this program component. Training is via mentoring or self-training on the part of individual staff. (No estimate at this time for required staff to fully implement this program component.)
Laboratory Resources - Existing SLOH laboratory resources are sufficient for this component of the program.
Funding - This monitoring is covered under 106 funds from EPA as well as GPR and segregated funds covering staff time. Funding levels vary depending on the level of sampling needed each year.
*Note: Wisconsin DNR operates 14 fish hatcheries throughout the state which use groundwater and/or surface water to hatch and rear fish for stocking in public waters. These hatcheries are subject to WPDES permits and are required to monitor effluents and submit results to the WDNR Wastewater Permits & Pretreatment Section. WDNR sets funds aside from the Basic Agreement with the State Lab of Hygiene to analyze these samples.

References

"WPDES Inspection Strategy", Wisconsin Department of Natural Resources, Bureau of Watershed Management, April 10, 2003

WHOLE EFFLUENT TOXICITY (WET) TESTING – BIOLOGICAL EFFECTS

Author: Kari Fleming

Status: Currently in Place but Reduced Implementation

This program has been in place since the late 1980s as an EPA mandated part of the NPDES program. However, staff time on this program has recently been reduced from 1 FTE to .5 FTE

Monitoring Objectives

Clean Water Act Objectives

- Establishing, reviewing and revising water quality standards
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific Objectives

The whole effluent toxicity (WET) testing program conducted by the Wisconsin DNR assesses the biological quality of WPDES permitted effluents statewide. Major objectives include the following:

- Conduct whole effluent toxicity (WET) tests on representative aquatic organisms in a variety of wastewater effluents from municipal and industrial sources for purposes of determining which facilities require permit limitations and/or monitoring conditions.
- Assess the success of wastewater treatment processes to remove toxic components and thereby meet the directives of whole effluent toxicity-based water quality standards in chs. NR 105 and 106, Wis. Adm. Code.
- Determine the relative acute toxicity of these effluents using the Lethal Concentration (LC_{50}), the effluent concentration at which 50% of organisms die during the test, and the relative chronic toxicity of these effluents using the Inhibition Concentration (IC_{25}), an estimate of the effluent concentration which causes a 25% reduction in growth or reproduction of the test organisms.
- Determine the relative toxicity of ambient waters upstream of effluent discharges.

Monitoring Design

All surface water dischargers (~550 non-industrial; ~290 industrial) are evaluated at the time of permit reissuance, to determine whether acute and chronic whole effluent toxicity (WET) monitoring and limits are appropriate. Of those that are flagged, approximately 250 acute tests and 225 chronic tests are performed each year by Wisconsin permittees, as required by their WPDES permits. Much of the sampling is done at the dischargers' expense, and DNR verifies their sampling accuracy with spot checks.

The "State of Wisconsin Aquatic Life Toxicity Testing Methods Manual" (Methods Manual) provides laboratory procedures and technical guidance for permittees and laboratories performing WET testing for the WPDES permit program. The Methods Manual is referenced in ss. NR 106.09, NR 219.04, and NR 149.22, Wis. Adm. Code, and WPDES permits and is required for use when determining compliance with WET-related permit requirements. All WET tests conducted for WPDES compliance must be performed according to the Methods Manual, by a lab certified or registered by the Wisconsin DNR.

The "Whole Effluent Toxicity (WET) Program Guidance Document" (WET Guidance Document) was created to supplement the Methods Manual and assist WDNR staff when determining permit requirements regarding WET testing and to assist permittees and their labs when conducting WET tests in accordance with these permits. The WET Guidance Document contains over 20 chapters, covering topics including WET sampling protocols, limits & monitoring, data review procedures enforcement, toxicity reduction evaluations, and more.

In addition to permit-required WET monitoring conducted by permittees, the Wisconsin DNR maintains a contract with the UW-Madison State Lab of Hygiene (SLOH) Biomonitoring Lab to perform WET tests in conjunction with compliance inspections and/or to supplement existing data. Under this basic contract, the SLOH performs toxicity tests on effluents, sediments, and receiving waters, and special studies as needed by the DNR. Approximately 30 acute tests and 25 chronic tests are performed each year by the SLOH, at the request of DNR field staff.

WET data collected during previous permit terms by the permittee and the SLOH Biomonitoring Lab is used by DNR staff to evaluate whether a WET limit is necessary and how much WET monitoring should be done in the reissued permit. The WDNR establishes WET limits "*to insure that substances shall not be present in amounts which are harmful to aquatic life...*" (ch. NR 106, Wis. Adm. Code). WET limits are given whenever WET and/or other data shows the potential for a toxicity problem.

Core and Supplemental Water Quality Indicators

Two species of aquatic organisms are routinely used in WPDES permit-required WET tests. The invertebrate (crustacean) *Ceriodaphnia dubia* represents primary consumers in the aquatic food chain. This is a native organism to Wisconsin ponds, quiescent sections of streams and rivers, and lakes. *C. dubia* is a vital link in the food chain because they feed on algae and are a significant source of food for small fish.

The fathead minnow, another native species, is the other extensively used test organism. It belongs to the family Cyprinidae (carps and minnows), the dominant freshwater family in terms of number of species. It thrives in ponds, lakes, ditches, and streams. Fathead minnows feed on organisms like *C. dubia* and are categorized as secondary consumers.

A third organism, *Selenastrum capricornutum*, a green algae, is not required in WPDES compliance tests, but is used (in addition to *C. dubia* and the fathead minnow) in all tests conducted by the SLOH to determine whether those effluents may cause adverse impacts to primary producers in the aquatic environment.

Acute and chronic WET tests consist of a primary control (receiving water, also used for dilution), a secondary control (standard lab water) and a minimum of five effluent concentrations. Acute tests last 48-96 hours and are used to determine the Lethal Concentration (LC_{50}), a statistical interpretation of acute data, which predicts the percentage of effluent that would cause 50% of the test population to die. Chronic tests last 4-7 days and are used to determine the Inhibition Concentration (IC_{25}), a statistical interpretation of chronic data which predicts the percentage of effluent that would cause a significant reduction (25%) in growth or reproduction of the test population, when compared to a control. The LC_{50} and IC_{25} are standard measures used to predict whether an effluent has the potential to have a damaging effect on the survival, reproduction or growth of aquatic life in the receiving stream.

Quality Assurance

All WET tests conducted for WPDES compliance must be performed according to the Methods Manual, by a lab certified or registered by the Wisconsin DNR, according to ss. NR 149.22 and NR 219.04, Wis. Adm. Code.

According to the Methods Manual, WET Test Report Forms are required to be submitted for demonstrating test completion and compliance with a WPDES permit. The WET data reported on these forms are checked by the Biomonitoring Coordinator to confirm test conditions, review reference toxicant testing and water chemistry information, check for compliance with test acceptability criteria, and a thorough review of test results and concentration-response relationships to determine the reliability of test results.

Data Management

All WET results are considered public information and are available upon request. Copies of the WET Report Forms are stored in WPDES permit and WET files for each facility. Data is captured electronically in

a WET database, within the "System for Wastewater Applications, Monitoring, and Permits" (SWAMP) computer system. Data summary reports can be generated and WET Checklists completed by the SWAMP system, using this electronic data.

Data Analysis/Assessment

Each WET test is evaluated by the Biomonitoring Coordinator at the time of testing to assess the level of toxicity, if any, present in the effluent sample (this data review process is described in detail in Chapter 1.5 of the WET Guidance Document). Reported lethality in acute tests and statistically significant reductions in growth or reproduction, in chronic tests are the primary data evaluated. At the time of permit reissuance permits staff, with assistance from the Biomonitoring Coordinator, evaluate previously collected WET data and other information, as described in Chapter 1.3 of the WET Guidance Document, to determine whether WET limits and monitoring is needed for the given discharge.

To help permit staff make WET limit and monitoring decisions, the "WET Checklist" was created in the "System for Wastewater Applications, Monitoring, and Permits" (SWAMP) computer system. Instructions for using the Checklist, selecting representative data, and assigning WET limits and monitoring, are given in Chapter 1.3 of the WET Guidance Document. The Checklist is designed to assist staff when assigning WET limits and levels of WET monitoring to individual discharges, based on their potential to exhibit toxicity or exceed water quality standards. The Checklist assigns points based on the number of factors present that increase the chances for toxicity. As the potential for toxicity increases, more points accumulate and more monitoring is recommended to insure that toxicity is not occurring.

Reporting

Hard copies of the results from permit-required tests and electronic copies of SLOH-conducted tests are submitted to the Biomonitoring Coordinator, usually within 45 days of the test's end. The Biomonitoring Coordinator completes a thorough data review, then distributes copies to appropriate permits and primary enforcement staff in the regions, usually within a few weeks of the lab report becoming available. Report forms then become part of the permit and WET files for the facility. A copy of the WET Test Report Form can be found on pp. 41-44 of the Methods Manual.

WET data is summarized, evaluated, and reported in water quality based effluent limit memos for each discharge at the time of permit reissuance.

Summaries of WET data trends and overall program results are reported biannually in the Wisconsin Water Quality Assessment Report to Congress (305(b) report).

The WET Guidance Document, Methods Manual, a list of certified labs, along with other WET program information and updates, is provided on the department's website, at:
http://dnr.wi.gov/org/water/wm/ww/biomon/biomon.htm.

Programmatic Evaluation

WET data from individual facilities is evaluated by department staff at each permit reissuance to determine if adjustments are needed in monitoring frequencies or if toxicity reduction evaluations (TRE) are necessary to determine the source of known problems. Statewide, historical WET and TRE data is also evaluated regularly by the Biomonitoring Coordinator to look for trends and to evaluate the usefulness of certain program tools (for example, to determine if the WET Checklist continues to be appropriate for use in most situations).

The WET Guidance Document, while comprehensive, is meant to be dynamic, and is therefore regularly updated. This is due in part to the impact science and technology has on the WET program and experience gained during implementation of the program. The maintenance of this document is the responsibility of the Biomonitoring Coordinator and it is updated and improved with input from department staff, permittees, and others as program needs dictate. To date, this document has been updated, on average, about once per year.

Since it's creation in November 1996, this document has been revised 6 times - the first revision took place in June 1997; the latest in March 2004.

Since the 1st Edition of the Methods Manual was created in 1996, Department staff have worked cooperatively with the SLOH, private laboratories, permittees, and others to develop and pilot revisions to WET methods. Staff have collected data and met face-to-face with laboratories and permittees who have experience with WET tests in order to gain their input and learn from their experiences; conducted research at the SLOH to develop and pilot proposed method revisions; and held discussions regarding implementation issues surrounding proposed method changes. The 2nd Edition of the WET Methods Manual will bring test methods up-to-date with the current science while providing needed details on specific testing and sampling procedures, types of tests, quality assurance procedures, etc. Promulgation of this 2nd edition (via incorporation by reference in chs. NR 106, 149, and 219, Wis. Adm. Code) is expected sometime in late 2005.

General Support and Infrastructure Planning

The Biomonitoring Coordinator serves as the principal staff expert and coordinator of the Bureau of Watershed Management's Biomonitoring and WET testing programs. Responsibilities include, but are not limited to the development, revision, and implementation of the Methods Manual and the WET Guidance Document; the review and evaluation of all WET and TRE data; the development and maintenance of WET-related permit language; and maintenance of the SWAMP WET database. This position also provides technical expertise and training to bureau and regional DNR staff and external customers on Biomonitoring and WET program issues. In recent years, due to staff reductions within the department, approximately 50% of this position is spent on issues unrelated to the WET program (historically, 100% of this position was devoted solely to the WET program).

In 1988 the SLOH Biomonitoring Lab began as a joint effort between the DNR and SLOH in both its physical construction and its self directed management style. From its inception, the lab's management team has included lab staff and representatives from the DNR. The SLOH/DNR Biomonitoring Team meets biweekly, as needed, to discuss the lab's activities, problems, and the needs and priorities of the DNR. This constant interaction and excellent communication results in a very high level of responsiveness to the DNR's needs.

Over the years, the SLOH has been able to provide many new and varied services to the WDNR. Unfortunately, even though the amount and variety of services provided by the SLOH has increased over the years, the level of monetary support that the DNR has been able to allocate to the SLOH has remained static. The DNR provides only $144,000 annually to maintain the Biomonitoring Lab and to contract for specific services. Under this basic contract, the SLOH performs toxicity tests on effluents, sediments, and receiving waters, and special studies as needed by the DNR (including test method development, training/guidance to private labs, water quality criteria development, etc.). The amount of this basic contract has not changed since the lab was built in 1988, even though the annual operating costs of the Biomonitoring Lab have risen to over $575,000. In order to provide the same level of service that the DNR has come to rely on, the SLOH/DNR Biomonitoring Team has had to find other ways to supplement the Lab's income. In recent years, other sources of revenue have included fee for service testing, outside grant money, the reallocation of other SLOH funds, and others.

References

Wisconsin Administrative Code. Chapter NR 105. Surface water quality criteria for toxic substances. WDNR, Madison, WI. Available from Document Sales, 202 S. Thornton Ave., Madison WI 53703. Phone (608) 266-3358.

Wisconsin Administrative Code. Chapter NR 106. Procedures for calculating water quality based effluent limitations for toxic and organoleptic substances discharged to surface waters. WDNR, Madison, WI. Available from Document Sales, 202 S. Thornton Ave., Madison WI 53703. Phone (608) 266-3358.

Wisconsin Administrative Code. Chapter NR 149. Laboratory Certification and Registration. WDNR, Madison, WI. Available from Document Sales, 202 S. Thornton Ave., Madison WI 53703. Phone (608) 266-3358.

Wisconsin Administrative Code. Chapter NR 219. Analytical Test Methods and Procedures. WDNR, Madison, WI. Available from Document Sales, 202 S. Thornton Ave., Madison WI 53703. Phone (608) 266-3358.

Wisconsin Department of Natural Resources. 1996 (with subsequent annual revisions). *Whole Effluent Toxicity (WET) Program Guidance Document*. Available at http://dnr.wi.gov/org/water/wm/ww/biomon/biomon.htm, or from the Department's Biomonitoring Coordinator at: Bureau of Watershed Management, P.O. Box 7921, 101 S. Webster St., Madison, WI 53707-7921. Phone (608) 267-7694.

Wisconsin Department of Natural Resources. 1996. *State of Wisconsin Aquatic Life Toxicity Testing Methods Manual*, Edition 1. (PUBL-WW-033-96) Available at http://dnr.wi.gov/org/water/wm/ww/biomon/biomon.htm, or from the Department's Biomonitoring Coordinator at: Bureau of Watershed Management, P.O. Box 7921, 101 S. Webster St., Madison, WI 53707-7921. Phone (608) 267-7694.

TOXICITY TESTING OF RECEIVING WATERS – BIOLOGICAL EFFECTS

Author: Kari Fleming

Status: Partially in Place

Though the framework for this program was established in the late 1980s and a low level of monitoring is currently being done, the program has not yet been fully implemented. Increased funding and staff time would be required to implement this program to its full extent.

Monitoring Objectives

Clean Water Act Objectives

- Establishing, reviewing and revising water quality standards
- Determining water quality standards attainment
- Identifying impaired waters
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Specific Objectives

Ambient toxicity tests are conducted on representative aquatic organisms in surface water samples taken from streams, rivers, and lakes statewide (including the Great Lakes) to achieve the following objectives:

- Identify causes of toxic pollution and sources (point or nonpoint) of surface water impairments,
- Determine the overall effectiveness of pollution control programs
- Characterize and define trends in the biological conditions of the state's waters
- Identify new or existing water quality problems and act as a triggering mechanism for special studies or other appropriate actions
- Assess the level of attainment of designated use categories and the causes of any impairment for reporting required under Sections 305(b) and 303(d) of the Clean Water Act
- Review existing water quality standards and establishment of water quality based effluent limits for WPDES permits in some situations.

Monitoring Design

WDNR maintains a contract with the UW-Madison State Lab of Hygiene (SLOH) Biomonitoring Lab and, under this basic contract, the SLOH performs toxicity tests on effluents, sediments, and receiving waters, and special studies as needed by the WDNR. WDNR field staff select targeted surface water sites for ambient toxicity testing of streams, rivers, and lakes (including the Great Lakes) in order to identify causes of pollution and sources (point or nonpoint) of surface water impairments, to determine the overall effectiveness of pollution control programs and/or to identify long term water quality trends. Selected sites often undergo a series of tests, usually upstream and downstream of potential pollution sources, to determine whether toxicity is present and where toxicity may be coming from.

Core and Supplemental Water Quality Indicators

- Three species of aquatic organisms are routinely used in ambient toxicity tests. The invertebrate (crustacean) *Ceriodaphnia dubia* represents primary consumers in the aquatic food chain. This is a native organism to Wisconsin ponds, quiescent sections of streams and rivers, and lakes. *C. dubia* is a vital link in the food chain because they feed on algae and are a significant source of food for small fish.
- The fathead minnow, another native species, is the other extensively used test organism. It belongs to the family Cyprinidae (carps and minnows), the dominant freshwater family in terms of number of species. It thrives in ponds, lakes, ditches, and streams. Fathead minnows feed on organisms like *C. dubia* and are categorized as secondary consumers.

- A third organism, *Selenastrum capricornutum*, is a freshwater green algae native to Wisconsin ponds, quiescent sections of streams and rivers, and lakes. It is a vital link in the food chain because they are a significant source of food for invertebrates and small fish. *S. capricornutum* is thought to be representative of higher order vascular plants, and is used in ambient toxicity tests to determine the presence of adverse impacts to primary producers in the aquatic environment.
- Acute and chronic ambient toxicity tests consist of a control (standard lab water) and a minimum of five test concentrations (surface water samples diluted with standard lab water). Acute tests last 48-96 hours and are used to determine the Lethal Concentration (LC_{50}), a statistical interpretation of acute data, which predicts the concentration of test material that causes 50% of the test population to die. Chronic tests last 4-7 days and are used to determine the Inhibition Concentration (IC_{25}), a statistical interpretation of chronic data which predicts concentration of test material that causes a significant reduction (25%) in growth or reproduction of the test population, when compared to the control. The LC_{50} and IC_{25} are standard measures used to predict adverse effects on the survival, reproduction or growth of aquatic life in the receiving stream.

Quality Assurance

The "State of Wisconsin Aquatic Life Toxicity Testing Methods Manual" (Methods Manual) provides laboratory procedures for toxicity testing. The "Whole Effluent Toxicity (WET) Program Guidance Document" (WET Guidance Document) was created to supplement the Methods Manual and contains guidance related to sampling protocols, data review procedures, toxicity reduction evaluations, and more.

Ambient toxicity tests are performed by the SLOH, which is certified by the Wisconsin DNR under both state (according to s. NR 149.22, Wis. Adm. Code) and federal (according to National Environmental Laboratory Accreditation Conference) standards. All tests are performed according to procedures in the Methods Manual.

Ambient toxicity data is reported to the Biomonitoring Coordinator, who confirms test conditions, reviews reference toxicant testing and water chemistry information, checks for compliance with test acceptability criteria, and reviews concentration-response relationships to determine the reliability of test results.

Data Management

All ambient toxicity test results are considered public information and are available upon request. Copies of test reports are stored in site-specific files maintained by the Biomonitoring Coordinator and regional staff. An electronic database is maintained by the SLOH and contains basic information regarding each test. The SWMS data system will provide an accessible location for this data starting in 2005.

Data Analysis/Assessment

Each test is evaluated by the Biomonitoring Coordinator at the time of testing to assess the level of toxicity, if any, present in surface water samples (this data review process is described in detail in Chapter 1.5 of the WET Guidance Document). Reported lethality in acute tests and statistically significant reductions in growth or reproduction, in chronic tests are the primary data evaluated. Field staff then use the data to identify water quality problems and the need for additional studies or other appropriate actions.

Reporting

Electronic copies of ambient toxicity tests are emailed by the SLOH tests to the Biomonitoring Coordinator, usually within 30 days of the test's end. The Biomonitoring Coordinator completes a thorough data review, then distributes copies to appropriate staff in regional offices.

Summaries of ambient toxicity data trends and overall program results are reported biannually in the Wisconsin Water Quality Assessment Report to Congress (303(d)/305(b) Report).

Programmatic Evaluation

Toxicity data from individual sites is evaluated by field staff to determine if adjustments are needed in monitoring frequencies or if toxicity reduction evaluations (TRE) are necessary to determine the source of ambient toxicity problems. Statewide, historical ambient toxicity and TRE data is also evaluated regularly by the Biomonitoring Coordinator to look for trends and to evaluate the success of the program.

General Support and Infrastructure Planning

The Biomonitoring Coordinator serves as the principal staff expert and coordinator of the Bureau of Watershed Management's Biomonitoring and Whole Effluent Toxicity (WET) testing programs. Responsibilities include, but are not limited to the development, revision, and implementation of the Methods Manual and the WET Guidance Document; and the review and evaluation of all ambient, WET, and TRE data. This position also provides technical expertise and training to bureau and regional DNR staff and external customers on program issues. In recent years, due to staff reductions within the department, approximately 50% of this position is spent on issues unrelated to the toxicity testing programs. Of the remaining 50%, almost all of this time is spent on the WET program, which leaves little staff effort to devote to ambient toxicity testing program support and coordination.

The SLOH provides many services to the Department, of which ambient toxicity testing is only a small portion. Unfortunately, even though the amount and variety of services provided by the SLOH has increased over the last 15 years, the level of funding the DNR has been able to allocate to the SLOH has remained static. The DNR provides only $144,000 annually to maintain the Biomonitoring Lab and to contract for specific services. Under this basic contract, the SLOH performs toxicity tests on effluents, sediments, and receiving waters, and special studies as needed by the DNR (including method development, training/guidance to private labs, water quality criteria development, etc.). The amount of this contract has not changed since the lab was built in 1988, even though annual operating costs at the Biomonitoring Lab have risen to over $575,000. In order to provide the same level of service that the DNR has come to rely on, the SLOH/DNR Biomonitoring Team has had to find other ways to supplement the Lab's income. In recent years, other sources of revenue have included fees for service testing, outside grant money, the reallocation of other SLOH funds, and others.

Due to shortages in staffing and funding, the ambient toxicity testing program is not well supported. Data is stored in the SLOH database but is not captured electronically by the Department and is not easily accessible by staff or external customers. Testing is limited and covers only a few sites scattered around the state on an annual basis. Tests are often representative only of short periods of time and are not repeated in successive years, so analysis of long-term trends is often impossible. In many cases, the number of samples in a given study is also limited, which makes the cause and source of any adverse effects difficult to determine.

References

Wisconsin Administrative Code. Chapter NR 105. Surface water quality criteria for toxic substances. WDNR, Madison, WI. Available from Document Sales, 202 S. Thornton Ave., Madison WI 53703. Phone (608) 266-3358.

Wisconsin Administrative Code. Chapter NR 106. Procedures for calculating water quality based effluent limitations for toxic and organoleptic substances discharged to surface waters. WDNR, Madison, WI. Available from Document Sales, 202 S. Thornton Ave., Madison WI 53703. Phone (608) 266-3358.

Wisconsin Administrative Code. Chapter NR 149. Laboratory Certification and Registration. WDNR, Madison, WI. Available from Document Sales, 202 S. Thornton Ave., Madison WI 53703. Phone (608) 266-3358.

Wisconsin Administrative Code. Chapter NR 219. Analytical Test Methods and Procedures. WDNR, Madison, WI. Available from Document Sales, 202 S. Thornton Ave., Madison WI 53703. Phone (608) 266-3358.

Wisconsin Department of Natural Resources. 1996 (with subsequent annual revisions). *Whole Effluent Toxicity (WET) Program Guidance Document*. Available at http://dnr.wi.gov/org/water/wm/ww/biomon/biomon.htm, or from the Department's Biomonitoring Coordinator at: Bureau of Watershed Management, P.O. Box 7921, 101 S. Webster St., Madison, WI 53707-7921. Phone (608) 267-7694.

Wisconsin Department of Natural Resources. 1996. *State of Wisconsin Aquatic Life Toxicity Testing Methods Manual*, Edition 1. (PUBL-WW-033-96) Available at http://dnr.wi.gov/org/water/wm/ww/biomon/biomon.htm, or from the Department's Biomonitoring Coordinator at: Bureau of Watershed Management, P.O. Box 7921, 101 S. Webster St., Madison, WI 53707-7921. Phone (608) 267-7694.

PUBLIC DRINKING WATER WELL MONITORING

Author: Laura Chern, Jeff Helmuth

Status:

Wisconsin was granted primacy for the Safe Drinking Water program in 1978. Amendments to the program have required the state to change its Drinking Water Program in order to keep primacy.

Monitoring Objectives

This program primarily meets the objectives of the Safe Drinking Water Act (SDWA), but data can also be used to support Clean Water Act objectives. Data is collected, analyzed and used to determine if surface and groundwater used to supply public water systems meets federal public health standards for contaminants in drinking water. Regulated contaminants include 15 inorganic compounds, 51 synthetic organic and volatile organic compounds, and 4 radionuclides. If the federal standards are not met, the water must be treated. Treated water is also monitored. Data in the Drinking Water System database is sometimes used to look at groundwater quality within basins. The following objectives may at different times be met by data collected as part of the states Drinking Water Program.

Clean Water Act Objectives

- Determining water quality standards attainment
- Identifying impaired waters
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

Monitoring Design

SDWA regulations require periodic sample collection and analysis to determine if water supplied by public water systems meets public health standards, called Maximum Contaminant Levels. EPA sampling rules are based on a Standardized Monitoring Framework (SMF) and require an assessment of potential contaminants to produce monitoring rules. Monitoring is done on a nine-year cycle that varies depending on the contaminant type, water source, and system type. The monitoring rules can be refined by the state into sampling requirements for each community system. Sampling requirements dictate how often samples are collected from each system as well as what substances the samples are analyzed for.

The purpose of the SMF is to standardize, simplify and consolidate monitoring requirements across contaminant groups. It increases public health protection by simplifying monitoring plans and coordinating monitoring schedules leading to increased compliance with monitoring requirements. The SMF reduces the variability within monitoring requirements for chemical and radiological contaminants across system sizes and types. The State of Wisconsin has primacy for implementing the SDWA. This allows the state to issue waivers, with EPA approval, which take into account regional concerns related to substances in drinking water systems.

Core and Supplemental Water Quality Indicators

- Bacteria
- Nitrate
- Nitrite
- Radionuclides
- Asbestos
- Inorganic Contaminants
- Synthetic Organic Contaminants
- Volatile Organic Contaminants
- Disinfectant By Products (Total Trihalomethanes and Haloacetic Acid 5s)

Quality Assurance

The Quality Assurance Project Plan is part of the Quality Management Plan approved by EPA as part of the Drinking Water Program.

Data Management

Data is stored in the state's Drinking Water System database and is available on the DNR website at http://prodmtex00.dnr.state.wi.us/pls/inter1/watr$.startup.

Data Analysis/Assessment

Central Office and Regional Drinking Water staff use the data to determine if drinking water standards are met. If there is a violation of a drinking water standard, a notice of noncompliance is issued. Further action taken can include a notice of violation followed by DNR referral to the Department of Justice. Drinking water system data for untreated groundwater is also used in generalized groundwater quality assessments.

Reporting

Reports are sent to EPA quarterly. A summary of this data is also included in the biennial 303(d)/305(b) Report.

Programmatic Evaluation

DNR work planning is changed in response to the changing needs of the program. The EPA audits the program.

General Support and Infrastructure Planning

Staff and Training – Each public water supply system does its own sampling. However, WDNR has approximately 72 FTE working in the public water program and they are all involved to some degree in assuring public wells are properly monitored. Staff is trained continuously to keep up with changes to the Safe Drinking Water Act.
Laboratory Resources –Many public water supplies have their water analyzed for bacteria and nitrates by the State Lab of Hygiene. This service is provided at no charge to the public water systems. The state lab and the DNR cover the cost of the analysis through the "basic agreement".
Funding - In FY 04 the cost to the basic agreement for the services described above was $863,342. Monitoring for other contaminants is at the drinking water system' expense. The Public Water program that coordinates and enforces monitoring is supported by both Federal and State resources. Federal support includes the public water system supervision (PWSS) grant (approx. $3,400,000/year) and the State Revolving Loan Fund (SRF) set-aside grant (approx. $1,400,000/year). This supplements approximately $2,000,000/year that is set aside from state funds. These grants include support for all aspects of the Public Water program including plan review, enforcement, operator certification, capacity development, underground injection control, the state revolving fund, and source water protection.

References

The Standardized Monitoring Framework: A quick Reference Guide, March 2004. EPA Publication No.816-F-04-010, Office of Water.

NON-DNR MONITORING PROGRAMS

Multiple resource agencies, educational institutions, and other entities across Wisconsin conduct water monitoring activities that provide key data for various types of management activities. Many of these efforts are done autonomously, while some are carried out in conjunction with WDNR staff or using WDNR-provided funding. The tables below list a range of non-DNR monitoring programs for both surface waters (Table 13) and groundwater (Table 14). Numerous special projects are also underway at any given time; these are not listed individually here.

Table 13. Non-DNR agencies that monitor surface water in Wisconsin.

Agency	Surface Water Monitoring Programs
USGS	• Operates the network of 126 streamflow gaging stations described in Tier 1 of this document, to provide real-time streamflow data. One hundred fifty four of these sites have greater than 5 years of record. DNR contributes funds to support a portion of these sites. • Operates a network of 98 high stream flow stage sites to provide information on flood frequency. • Water-quality and elevation is monitored at 10 lake stations in the State to provide long-term information • Fifteen lakes are monitored for stage on a continuous or periodic basis • One hundred seventeen water-quality sites are monitored continuously or on a periodic basis to meet the needs of various USGS District projects • Thirty-three sites provide continuous record of precipitation quantity • Sediment information is collected at 16 sites on a daily or periodic basis (these sites are part of other USGS monitoring efforts and the number varies annually) • Conducts about 60 special surface-water projects every year that help to support the monitoring described in this table. A variety of organizations contribute resources to these projects * • USGS Midwest Environmental Sciences Center - Mississippi River monitoring sediments, contaminants, nutrients, fisheries, macroinvertebrates, etc. • USGS National Water Quality Assessment (NAWQA) collects fish, macro-invertebrate, algae, habitat, and water quality data at one long-term site (Popple River) and at a number of short-term project sites focusing on mercury, nutrients, and urban land use impacts. • USGS Great Lakes Science Center - Lake Michigan and Lake Superior lake-wide forage surveys
DATCP	DATCP staff periodically collect pesticide data from surface waters while evaluating impacts associated with agricultural chemical storage/transfer facilities. WDNR serves in an advisory capacity to help DATCP staff understand the magnitude of any detected pesticides. WDNR have recently discussed the ability for the two agencies to share these data.
DOT	Conducts monitoring associated with road projects, primarily through private contractors
NRCS	• Monitors all wetland restoration projects constructed under the Wetland Reserve Program. Currently vegetation is the primary focus.

	• Some monitoring is being conducted on the early watershed-based EQIP projects • Effectiveness of Conservation Reserve Enhancement Program (CREP) is to be evaluated through stream monitoring; DNR will be a cooperator on this project
Army Corps of Engineers	• Monitors Mississippi River for flood control and navigation • Monitors Great Lakes water levels • Monitors up to 1,000 wetland restoration sites in MN and WI. Restorations were for purposes of compensatory mitigation. • Does contractual, short duration work on a variety of projects
WI Geological & Natural Hist. Survey	Maintains long term data and special studies of aquatic plants on 50 lakes
Metropolitan Council (Twin Cities, MN)	Long Term Trend monitoring stations on the St. Croix River
WI Valley Improvement Corps	Manages water levels and flows for the Wisconsin River and several lakes and flowages, primarily for flood control purposes
University of WI	• Long Term Ecological Research (LTER) sites • Discovery Farms, a multi-agency partnership coordinated through UW-Extension, conducts monitoring to determine how alternative farm practices impact water quality. Pioneer farms also conduct some surface water monitoring through the UW. • UW-Madison Center for Limnology maintains the North Temperate Lakes - Long Term Ecological Research spatial data catalog (Madison lakes and Trout Lake Regions) • UW Environmental Remote Sensing Center provides statewide water clarity data • UW-Milwaukee WATER Institute operates a pelagic monitoring buoy in Lake Michigan. It is equipped for both meteorological measurements and water quality measurements (profiling surface to bottom). • UW-Stevens Point Water & Environmental Analysis Lab (WEAL) supports research and provides analytical services on lake and stream water for homeowners throughout the state, businesses, and consulting firms • Various other monitoring projects/activities throughout the state, including water quality, fish, sediments, among others
US Fish & Wildlife Service	Inter-jurisdictional waters (i.e., Great Lakes, Mississippi River), sea lamprey, ruffe, etc. Also assists GLIFWC with monitoring on tribal lands.
Great Lakes Indian Fish & Wildlife Commission	Conducts fish and water quality monitoring in the ceded territory in conjunction with tribal governments and USFS Fishery Resource Office (FRO) in Ashland
Tribal governments	Monitor shared resources in the ceded territory
Local governmental units, lake associations, etc.	• Lake planning and management grants fund an assortment of short and medium duration efforts that may involve counties, municipalities and lake associations and districts. WDNR provides 75% funding for these activities, sometimes supplemented by USGS funds. • Local governments conduct a variety of surface water monitoring programs, often in partnership with one another or state or county agencies.
Local Public Health Departments	• Public Health Departments throughout the state have jurisdiction over beach closures and/or advisories in the event of elevated pathogen counts or blue-green algae capable of producing toxins. Currently, no formal program is coordinated statewide and some counties actively monitor local swimming areas while many do not. • Local health departments and students from UW Oshkosh as a part of the

	Wisconsin Beach Monitoring Program are monitoring waters from 123 beaches along Lake Michigan and Lake Superior. This effort is done in accordance of the Beaches Environmental Assessment and Coastal Health (BEACH) Act.
County Health or Land Cons. Depts.	A few fund surface water monitoring efforts
Schools & Citizen-based programs	• Some local schools operate short and long term surface water monitoring • A variety of locally based citizen monitoring groups may conduct local monitoring (many of these belong to the DNR-sponsored statewide Self-Help Lakes Program & Water Action Volunteers described in Tier 1)
Sewerage Districts	• Milwaukee Metropolitan Sewerage District (MMSD) monitors water quality in Milwaukee-area rivers and Lake Michigan • Green Bay Sewerage District monitors Green Bay-area rivers and L. Michigan
Wastewater Permittees	Permittees that need to justify higher metals limits based on dissolved metals criteria may hire the Lab of Hygiene to take receiving stream samples for total and dissolved metals monitoring. Other water quality parameters are also generated as part of this monitoring.
Hydroelectric Dam owners	Can be required to do short term water quality monitoring as part of their FERC licensing process, to assess the effects of dam operation on in-lake and downstream water quality. Some monitor on a regular basis.

Table 14. Non-DNR agencies that monitor groundwater in Wisconsin.

Agency	**Groundwater Monitoring Programs**
Department of Commerce	Petroleum Environmental Cleanup Fund Act (PECFA)
CWGC	Research, outreach and private well sampling
DATCP	Pesticide monitoring and evaluation of atrazine rule
Department Of Transportation	Highway salt contamination along right of ways
State Laboratory of Hygiene (SLOH)	Private wells sampling and research
USGS	• Sixty groundwater wells will be monitored about every two years for stage and water quality constituents as part of the Western Lake Michigan NAWQA land use studies. • Sixty groundwater wells will be monitored about every 2-5 years for stage and water quality constituents as part of NAWQA major aquifer studies. • A GW level monitoring network of 174 wells throughout the state are monitored on a continuous or periodic basis • About 10 special GW water quality and ground water flow studies are conducted in cooperation with a variety of governmental entities annually.*
WGNHS	Special studies, groundwater level network
County Health or Land Cons. Depts.	A few fund groundwater monitoring efforts
UW-Stevens Point Water & Environmental Analysis Lab (WEAL)	Supports research and provides analytical services on drinking and groundwater for homeowners throughout the state, businesses, and consulting firms

* Contributions to these efforts come from federal, state, and local agencies (cities, counties, villages, sewerage districts and regional planning districts), regulated dam owners, Native American Tribes, and individual lake districts.

MONITORING PROGRAM LOGISTICS

QUALITY ASSURANCE

Quality Management Plan (QMP)

The WDNR has a Quality Management Plan (QMP) and an Evaluation System Manual Code (MC 9314.1) in place that establishes processes and protocols that the state's monitoring program must meet. Required under EPA Order 5360.1 A2 as part of the WDNR's Agency-Wide Quality System, the QMP documents the WDNR's quality policy, describes its quality system, and identifies the environmental programs to which it applies. It can be accessed on the WDNR's intranet site at http://intranet.dnr.state.wi.us/int/es/science/quality/qmp/qmphelp.htm. The WDNR QMP was adopted in 2000 and is scheduled for review and revision by 6/30/05, allowing for additions or modifications to quality assurance processes currently in place.

Quality Assurance Project Plans (QAPP)

The WDNR is also required by EPA Order 5360.1 A2 to submit a QAPP for those programs and projects receiving EPA funds. QAPPs are project-specific planning tools documenting how planning, implementation, and assessment will achieve the desired results through consistent, accurate data collection. Except in emergency cases, QAPPs must be approved by EPA prior to any data gathering work or use. The process can be lengthy, so programs should allow plenty of time for review and approval. The EPA publication *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5, March 2001) describes the specifications, recommends the format and delineates the approval process. The guidance emphasizes that precision and accuracy of data shall be assessed on all monitoring and measurement projects, without exception.

DNR Field Sampling Protocols & Staff Training

Standard monitoring protocols are delineated in WDNR's *Environmental Sampling & Laboratory Services Guide: WI DNR Field Procedures Manual*, online at http://intranet.dnr.state.wi.us/int/es/science/ls/fpm/. Training of field staff for consistency in data collection and recording is critical to the success of the monitoring program. Training in taxonomy, deployment of field gear, and general program implementation is periodically made available to all staff. All monitoring protocols employed, at a minimum, meet the Department's data standards as developed by the Aquatic and Terrestrial Resources Inventory (ATRI) Team. Further, database quality assurance protocols are built into many of the database systems used by staff.

USGS Standards and Methods

USGS collaborates with several WDNR monitoring programs and provides shared databases. USGS standard protocols can be found at the websites below.

- USGS Water Quality field Manual - http://water.usgs.gov/owq/FieldManual/
- NAWQA biology protocols - http://water.usgs.gov/nawqa/protocols/bioprotocols.html
- NAWQA sampling and analyses protocols - http://water.usgs.gov/nawqa/protocols/methodprotocols.html
- USGS Techniques of Water Resources Investigations - http://water.usgs.gov/pubs/twri/
- NAWQA Quality Control Guidelines - http://water.usgs.gov/nawqa/protocols/OFR97-223/index.html
- USGS Quality Assurance - http://water.usgs.gov/owq/quality.html

State Lab of Hygiene (SLOH) Quality Controls

Most WDNR water quality analyses are completed by the State Laboratory of Hygiene (SLOH). The SLOH is certified by both the State of Wisconsin and the National Environmental Laboratory Accreditation Conference, with approved quality assurance procedures. Field and lab staff conduct various types of quality assurance tests, including split samples, proficiency testing, and reference toxicant testing.

DATA MANAGEMENT

Data management and analysis are key to using monitoring information wisely in decision making processes. Currently, data from WDNR water monitoring programs is stored in several databases, some (but not all) of which are accessible to the public via the internet. The WDNR is currently developing an internet accessible tabular and spatial data system, the Surface Water Monitoring System (SWMS), which will consolidate some systems and provide areas for data storage where PC-based or offsite storage was previously the only alternative. This section describes SWMS and other databases currently in use, including their related websites, and is followed by a table indicating which monitoring programs store data in each database.

An important precursor to the development of SWMS is the cleaning of backlogged STORET station data, which is a precursor to migrating the actual sample results into STORET. The assignment of station numbers to each monitoring site, a step that is necessary for STORET entry, has been previously under staffed and under supported. A concerted effort to assign station numbers and enter backlogged data is underway. Station data will be cleaned by March 2005, and backlogged results will be migrated with the help of USEPA contractors in 2005-2006. The new SWMS system will prevent such backlogs in the future by automating the assignment of station numbers.

Surface Water Monitoring System (SWMS)

Historically, data from different WDNR water monitoring programs has been stored in a number of disparate databases, each used by specific staff. In July of 2004, a 104(b)(3) grant was secured through EPA to develop a unified system to house and extract data from these various systems where possible. The Surface Water Monitoring System (SWMS) will enable all staff to access comprehensive sets of data for each waterbody, and to view monitoring results geographically using an ArcIMS Web mapping application called Watershed Webviewer. It will also create efficiencies by allowing monitors to click and print field forms, using consistent forms for different input screens, allowing automatic generation of station numbers and mailing forms for the State Lab of Hygiene, and thereby enabling timely entry of results into the STORET system. Users will be able to access the system via the Internet using a logon and password.

Programmers are starting work on SWMS in October, 2004, and expect its completion by the end of 2006. Databases that are currently slated for inclusion in SWMS include:

- Sediments
- Exotics
- River Automonitoring (for BOD loading capacity)
- Lake Water Quality
- Thermal
- Long Term Trends data (Rivers non-chemistry data)
- Macroinvertebrates
- Satellite water clarity
- Plants (UW-Herbarium & Lakes)
- Rivers
- Water Action Volunteer data
- Miscellaneous Lakes data

More information about SWMS is available on the internal DNR website http://intranet.dnr.state.wi.us/int/water/fhp/storet/project/project.asp.

STORET and related websites

STORET (short for STOrage and RETrieval) is a national EPA repository for water quality, biological, and physical data and is used by state environmental agencies, EPA and other federal agencies, universities, private citizens, and many others. STORET consists of two data management systems: the STORET Legacy Data Center (LDC), and Modernized STORET. The LDC is a static, archived database and Modernized STORET is an operational system actively being populated with water quality data.

The LDC contains historical water quality data dating back to the early part of the 20th century and collected up to the end of 1998. Modernized STORET contains data collected beginning in 1999, along with older data that has been properly documented and migrated from the LDC. Both systems contain raw biological, chemical, and physical data on surface and ground water. Each sampling result in the LDC and in Modernized STORET is accompanied by information on where the sample was taken (latitude, longitude, state, county, Hydrologic Unit Code and a brief site identification), when the sample was gathered, the medium sampled (e.g., water, sediment, fish tissue), and the name of the organization that sponsored the monitoring. In addition, STORET contains information on why the data were gathered; sampling and analytical methods used; the laboratory used to analyze the samples; the quality control checks used when sampling, handling the samples, and analyzing the data; and the personnel responsible for the data.

Both the LDC and Modernized STORET are web-enabled and available to the public. With a standard web browser, both systems can be browsed and queried interactively and files can be created for download. The website is currently located at http://www.epa.gov/storet.

WDNR 24K Hydrography Layer

The WDNR reviewed several existing sources of digital hydrography data, including the US EPA's 1:100,000 scale River Reach File 3 (precursor to the National Hydrography Dataset) and the USGS's 1:100,000 scale Digital Line Graph (DLG) formats, and determined that they could not meet the WDNR's specific needs for a GIS hydrography layer. Surface water related data has been collected by WDNR staff mainly from USGS 7.5 minute quad maps. These maps represent a higher level of detail and allow the users to locate significantly more information than 1:100,000 scale sources. The WDNR 24K hydro website is available on the Internet at http://dnr.wi.gov/maps/gis/datahydro.html, and provides the following:

- Information about the current version of the statewide GIS layer
- Specific information about the data sources for the layer
- Access to all the data documentation
- Information on how to aquire a copy of the data

Waterbody Assessment Display and Reporting System (WADRS)

WADRS is an intranet-based tabular and spatial assessment database that supports implementation and reporting under the Federal Clean Water Act. This database holds Clean Water Act Section 305(b) and 303(d) data, designated uses, codified uses, and other data describing the quality of Wisconsin's rivers, lakes, and Great Lakes shoreline. WADRS uses the table structure and the reporting requirements identified in USEPA's integrated reporting strategy and programmed into the ADB V 2.0 as its base and then includes additional enhancements specific to the state's water management needs. Data from this system will be sent to EPA periodically.

DNR Lake Water Quality Database

The DNR Lake Water Quality database contains DNR Baseline Lake data (2003 to present) as well as data collected by volunteers in the Self-Help Lakes program (1986 to present) and data collected through lake grants (2003 to present). Past data is continuously added as time allows. Data includes water clarity and chemistry data as well as metadata. This database is available on the web at http://dnr.wi.gov/org/water/fhp/lakes/lakesdatabase.asp.

UW-Stevens Point Bug Biomonitoring database

WDNR macroinvertebrate biomonitoring results are stored in BUG Program Version 6.0, available for download at http://www.uwsp.edu/water/biomonitoring/index3.htm. The program includes a listing of aquatic macroinvertebrates and their known associated tolerance values, and provides for the calculation of 25 commonly used macroinvertebrate community metrics for bioassessment of water quality. WDNR biomonitoring data can be downloaded by districts or regions and by year. This database is accompanied by *The Macroinvertebrate Data Interpretation Guidance Manual*, designed to assist WDNR staff in interpreting macroinvertebrate data reported to WDNR through contractual arrangements with the University of WI-Stevens Point.

Fish and Habitat Database

Created in 2000, the Fish and Habitat Database stores information on Great lakes and inland fish stocking, inland fisheries assessments, and small stream habitat surveys. Maintained and developed at the USGS Water Resources Offices in Middleton WI under contract with the WDNR, the Fish and Habitat Database is an Internet data entry and reporting system. All WDNR staff (e.g. field biologists, technicians, hatchery staff, and fisheries research scientists) have unlimited access to the system for entering and downloading raw data as well as standardized summary reports (http://infotrek.er.usgs.gov/wdnr_bio/). Selected data are also available to the general public at the following address (http://infotrek.er.usgs.gov/wdnr_public/). Data currently not available through the public website are available upon request or through standardized reports available at each field office.

USGS National Water Information System (NWIS) and related websites

As part of the U.S. Geological Survey's (USGS) program of disseminating water data to the public, the USGS maintains a distributed network of computers and fileservers for the storage and retrieval of water data collected through its activities at approximately 1.5 million sites around the country. This system is called the National Water Information System (NWIS). Many types of data are stored in this NWIS network, including: site information, time-series (flow, stage, precipitation, chemical), peak flow, ground water, and water quality.

Data is accessible to the public through NWISWeb, at http://waterdata.usgs.gov/nwis. Its goal is to provide both internal and external users of USGS water information with an easy to use, geographically-seamless interface to the large volume of USGS water data maintained on 48 separate NWIS databases nationwide. Data is updated from the NWIS sites on a regularly scheduled basis; real-time data is transmitted to NWISWeb several times a day. NWISWeb provides several output options: real-time streamflow, water-levels and water quality graphs, data tables and site maps; tabular output in html and ASCII tab delimited files; lists of selected sites as summaries with reselection for details.

Data are retrieved by category of data, such as surface water, ground water, or water quality; and by geographic area. Further refinement is possible by selecting specific information and by defining the output desired. NWIS data comes from all 50 states, selected territories and border stations, from 1896 to present. Of the 1.5M sites with NWIS data, 80% are wells; 350,000 are water quality sites; and 19,000 are streamflow sites, of which over 5,000 are real-time. NWISWeb contains about 4.3 million Water Quality Samples; and 64 million Water Quality Sampling Results.

USGS Great Lakes Beach Health database and related websites

Created in 2000, the USGS Great Lakes Beach Health database stores data from WDNR, various local cooperators throughout the state, and the public. It stores data on water quality samples from Great Lakes swimming beaches and other related information. Data is available to the public through the WDNR Beach Health website: http://www.wibeaches.us.

System for Wastewater Applications, Monitoring, and Permits (SWAMP)

The SWAMP is an Oracle-based computer system designed to assist with management of the Wisconsin Pollutant Discharge Elimination System (WPDES) Permit Program. This system has the capability to generate WPDES permit applications, store facility information, generate and issue WPDES permits, determine whole effluent toxicity requirements, generate monitoring forms, store permittee monitoring data and analyze compliance, generate/store permit-related documents, track compliance events, and calculate annual environmental fees based on reported discharges. The database became active in January 1999; permitting capability became active in 2000.

For monitoring purposes, SWAMP has the capability to track sample point and monitoring requirements, display data and documents, compare reported data to reporting requirements and display apparent violations, warnings, and exceedances, and produce reports. Discharge, groundwater, sludge, and land application self-monitoring data is stored and available for downloading. Electronic reporting of discharge data is currently being implemented. Monitoring data that is held in SWAMP is downloaded, manipulated, and displayed as annual loading in the FACTs system, available on the WDNR website. A list of permittees with contact info can be found at http://dnr.wi.gov/org/water/wm/ww/permlists.htm, and location information for groundwater monitoring wells will be available in a WDNR Drinking Water web page soon.

Drinking Water System (DWS)

The purpose of the Drinking Water System is to enforce Safe Drinking Water Act regulations covering public water systems. The DWS is a data system created and maintained by the DNR's Bureau of Drinking Water and Groundwater. It contains the monitoring and reporting requirements for each public water system and their drinking water sampling results. It also includes violations for any missing requirements and exceedances of the maximum contaminant levels (MCLs). This system is used to report public water supply data to USEPA as required by the Safe Drinking Water Act. The DWS also contains information on public and private well construction and high-capacity well approvals. A subset of data is available on the Internet for public access at http://www.dnr.state.wi.us/org/water/dwg/DWS.htm.

Groundwater Retrieval Network (GRN)

This system reports data from public and private drinking water supply wells, non-point source priority watershed projects, special groundwater studies, and the Bureau of Waste's Groundwater and Environmental Monitoring System (GEMS) landfill monitoring wells. Data covers the period from the early 1970s to present for the Public Water Supply data, 1988 to present for the Private Water Supply, priority watershed and special study data, and from the mid-1970s to present for the GEMS database. Not all programs that currently generate groundwater-related data are linked into the GRN system. Data from the Bureau of Remediation and Redevelopment (LUST, spills, or remediation sites) as well as data from the Bureau of Watershed Management (wastewater treatment facilities and land spreading sites) is not currently retrievable through the GRN system. A subset of data is available on the Internet for public access at http://prodmtex00.dnr.state.wi.us/pls/inter1/grn$.startup.

REPORTING

Data from WDNR monitoring activities are analyzed, interpreted, and summarized to develop reports for EPA and the public. Below are some of the most common reporting mechanisms used across programs.

Integrated 303(d)/305(b) Report: Water Quality Report to Congress & List of Impaired Waters

WDNR is preparing to move from separate 303(d) and 305(b) reports to a single, integrated document as requested by EPA. The descriptions below describe the separate reports that have been used in the past and store much of the information provided by WDNR's monitoring programs to date.

305(b) Report: Water Quality Report to Congress: Section 305(b) of the Federal Clean Water Act requires that states report their assessment of the quality of waters to the Congress. These biennial reports are referred to as "305(b) Reports" and provide a summary of water programs and resource condition on a statewide basis. The 305(b) report structure and content is currently under evaluation by an internal WDNR team and will be modified for the next iteration to provide more integrated reporting between 303(d) and 305(b) reports. 305(b) reports are available on the web at http://www.dnr.state.wi.us/org/water/wm/watersummary/Waterqualityassessment.html or in hard copy at public libraries and DNR offices.

303(d) Report: List of Impaired Waters

Section 303(d) of the federal Clean Water Act requires each state to periodically submit to EPA for approval a list of impaired waters. Impaired waters are those that are not meeting the state's water quality standards. The most recent 303(d) list for Wisconsin was approved by the EPA on September 3, 2004. In the future, an integrated 303(d)/305(b) Report will be prepared.

The WDNR is currently in the process of updating the listing methodology used to place waters on the 303(d) list. It is expected that this will be completed and adopted into state code in summer of 2007 and that the results of that effort will lead to updates to this *Strategy*. The 303(d) list is available on the web at http://www.dnr.state.wi.us/org/water/wm/wqs/303d/303d.html.

USGS Reports

Water-Resources Investigations in Wisconsin is a biennial report produced by the USGS. It describes a variety of projects done throughout the state supporting all aspects of water resource management and research. Summaries of several joint WDNR-USGS projects are included in this document. The full report, as well as project descriptions organized by team, are available online at http://wi.water.usgs.gov/projects/index.html.

A Summary of Cooperative Water Resource Investigations focuses specifically on joint USGS-WDNR water research programs. It is produced biennially through USGS and WDNR, and describes these agencies joint water research programs. This report is not available online, and distribution is limited.

Annual *Water Resources Data: Wisconsin* report. This is one of a series of annual reports (one per state) that documents hydrologic data gathered from USGS surface and groundwater data collection networks. Each state's data reports are available online at http://water.usgs.gov/pubs/wdr/.

The annual W*ater Quality and Lake Stage Data for Wisconsin Lakes* publication focuses specifically on lake data.

General Support and Infrastructure Planning

Budget Analysis

A detailed budget analysis has been conducted to determine the level and source of funding currently allocated to each monitoring programs. This information will be further assessed by the Monitoring Team to determine whether shifts in funding are appropriate to meet the goals of this *Strategy*. Additionally, the Basic Agreement with the State Lab of Hygiene, which supports most of WDNR's sample analyses, is now under internal review to consider reallocation of funds to best fit program needs.

State Laboratory of Hygiene (SLOH)

In existence since 1903, the State Lab of Hygiene (SLOH) is the WDNR's primary source for sample analysis. WDNR has a Basic Agreement with the SLOH for approximately 2,350,000 annually, which is allocated from GPR and covers all DNR programs. Of this, $332,000 is allocated to the Bureau of Fisheries Management & Habitat Protection, $148,000 to the Bureau of Watershed Management, and $332,000 to the Bureau of Drinking Water & Groundwater (2004 budget). The SLOH provides clinical, environmental, and industrial analytical services, specialized public health procedures, reference testing, training, technical assistance and consultation for private and public health agencies. The SLOH Environmental Health Division specializes in analytical chemistry and environmental biology. Their services include:

- Organic Chemistry Testing
- Inorganic Chemistry Testing
- Biomonitoring Testing
- Water Microbiology Testing
- Toxicology Testing
- Environmental Virology Testing
- Radiochemistry Testing
- Environmental Proficiency Testing

The SLOH is part of the University of Wisconsin-Madison, through which they perform research and instruction related to public and environmental health protection. More information is available online at http://www.SLOH.wisc.edu/.

Research Support

The Monitoring Program is directly supported by both internal and external research functions. WDNR monitoring staff work closely with the Bureau of Integrated Science Services to develop projects that support monitoring. Funding from the monitoring program is often provided to our research partners to address specific problems. Bureau of Integrated Science Services staff serve on the Baseline Lakes and Baseline Streams Subteams, and one staff member coordinates the Baseline Rivers efforts. WDNR also routinely develops contracts with the University of Wisconsin System to fund research on monitoring issues.

IMPLEMENTATION

TEN-YEAR TIMELINE

The Monitoring Team has developed a ten-year timeline from 2005 to 2015 (Figure 4). Because of uncertainties in budget allocations, this timeline should be viewed as flexible and will evolve as projects move forward. The timeline is divided into five sections:

- Monitoring Teams and Programmatic Evaluation
- Tier 1 Baseline monitoring
- Tier 2 & 3 monitoring for targeted evaluations and management effectiveness/compliance
- Database Development
- Other (e.g. budget analyses, Quality plans)

The Water Division Monitoring Team and Subteams will each be re-evaluated and reconstituted, to meet on a regular basis throughout the year (quarterly meetings are not shown on timeline). These teams will be charged with programmatic direction and evaluation, and are described more fully later in this chapter (see "Responsibility for Program Implementation & Evaluation").

Tier 1 monitoring is subdivided into Subteam planning. Each Subteam has identified outstanding issues that they will work to resolve in order to refocus current monitoring effort. These items are shown on the timeline as short- to mid-range plans scheduled for the next three years (through 2008). Each Subteam will also have ongoing evaluation and planning schedules that will occur on a regular basis, to continue to identify future directions. Because Tiers 2 and 3 are conducted on an as-needed, targeted basis, it is more difficult to project future program needs in these areas.

Other related initiatives include database development, QMP review, and budget planning. Database development primarily focuses on the completion of the Surface Water Monitoring System, which will allow integrated access to a majority of the databases currently housing monitoring data. The Quality Management Plan will be reviewed and revised every five years, with the current revision pending in June 2005. Budget initiatives for monitoring funding will be prepared biennially.

Through ongoing review and evaluation of these monitoring programs, the WDNR is committed to steady progress towards meeting current and future needs.

Figure 4. Ten-Year Implementation Timeline for Wisconsin's Water Resources Monitoring Strategy.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Monitoring Teams & Programmatic Evaluation	A C B E	D	C E	D	C E	D	C E	D	C E	D	C E

A. Reconstitute Water Division Monitoring Team (quarterly meetings are not charted above) – Jan. 2005
B. Reevaluate Monitoring Subteams; convene Citizen Monitoring Subteam (meetings as needed are not charted above) – Jan. 2005
C. Set biennial sampling designs – Jan/Feb. of odd years
D. Review progress toward meeting biennial sampling designs & adjust course as needed – Jan/Feb of even years
E. Biennial work planning – Jan/Feb of odd years

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Tier 1 Monitoring (Baseline)	L1-2 A W1-3 C1 G1 S1-5 Q1-3	L3 B W4-6 R1 C2 G1-2 S6 S7 Q4	W7 G3	B R2		B		B		B	

Integrated 303(d)/305(b) Reporting
A. Form team to evaluate the current 305(b) structure and develop an integrated 303(d)/305(b) Report – June 2005
B. Assemble data for 303(d)/305(b) Reports biennially – due April of even years

Lakes Subteam Outstanding Issues:
L1. Evaluate LTT lakes data and recommend uses & modifications – Spring 2005
L2. Implement satellite-based technique for lake trophic assessment – Spring 2005
L3. Modify existing data management systems to accommodate satellite-based trophic assessment system – Early 2006

Streams Subteam Outstanding Issues:
S1. Finalize wadable baseline site selection criteria and implement statewide – Feb. 2005
S2. Determine how to make invertebrate data on wadable streams more useful for management, or whether the invertebrate sampling component should be removed – Feb. 2005
S3. Complete evaluation of LTT streams data and recommend uses & modifications – Spring 2005
S4. Compare current targeted sampling effort with a probability-based sampling design (EMAP) – May 2005
S5. Complete prototype of Lyons' model for describing fish community condition by strata – Summer 2005 (will be refined after initial implementation)
S6. Application of a statewide probability-based sampling effort – Jan. 2006
S7. Sample least-impacted reference streams to develop statewide reference conditions – Late 2006

Rivers Subteam Outstanding Issues:
R1. Decide if an invertebrate component should be added to large rivers – End of 2006
R2. Evaluate performance characteristics of fish sampling methods; determined sampling frequency – annual vs. rotations – 2008

Wetlands Subteam

W1. Complete development of wetland project tracking geodatabase; begin collecting data – Spring 2005
W2. Complete Milwaukee River and Mead Lake Level 1 Wetland Assessment pilot projects – Oct. 2005
W3. Explore possibility of developing wetland monitoring pilot project with Wisconsin Wetlands Assoc. and other partners – 2005
W4. Complete statewide Reed Canary Grass mapping – Oct. 2006
W5. Complete Floristic Quality Assessment Survey in Southeast Region – Oct. 2006
W6. Complete Level 1 assessment for focus watersheds in Upper Rock River Basin – Oct. 2006
W7. Work with Wisconsin Wetlands Association to develop a landowner/citizen's manual "A Guide to Understanding Wetland Health" – target completion by Spring 2007

Citizen Monitoring Subteam:

C1. Create Citizen Monitoring Subteam – Jan. 2005
C2. Begin pilot citizen monitoring season –Spring 2006

Water Quality Subteam

Q1. Work with Statewide Volunteer Coordinator to identify and train local health departments & volunteers to conduct pathogen monitoring. – Early 2005
Q2. Identify sites on lakes, wadable rivers, and non-wadable streams where water chemistry samples will be collected in sampling season 2005 – Early 2005
Q3. Allocate basic agreement funding to cover analytical costs associated with ambient monitoring – Winter 2005
Q4. Calculate load assessments and compare to load assessments calculated for LTT sites. – March 2006

Groundwater Subteam: *the Groundwater Subteam timeline is highly tentative due to funding restrictions in the groundwater program

G1. Complete reports for 'Condition of the Groundwater Resource' series – end of 2005; end of 2006
G2. Complete baseline assessment of shallow aquifer system (Phase I) – end of 2006
G3. Complete baseline assessment of deep confined aquifer systems (Phase II) – end of 2007

Tier 2 & 3 Monitoring (Targeted & Management Monitoring)

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A	B	C A		A	D	A		A		A

A. Regions identify which targeted sites or special projects should be incorporated into work plans – Jan of odd years
B. Create methodology for evaluating nonpoint source performance standards – Fall 2006
C. 303(d) listing methodology adopted into Code – Summer 2007
D. Sampling of all public wells is completed on a 9-year cycle – complete in 2010 (cycle repeats)

Database Development	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	A B C D	E									

A. Complete data backlog cleaning and entry into STORET – Jan. 2005
B. Surface Water Monitoring System (SWMS) Station Module on Intranet for staff site to request sites & print lab slips– Mar. 2005
C. SWMS Phase 1 Database available on Internet (includes lakes, rivers, streams, exotics) – June 2005
D. SWMS Phase 2 Database available on Internet (includes sediment, plants, etc.) – Dec. 2005
E. SWMS fully implemented; reporting and querying capabilities completed – Sept. 2006

Other	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	A B		B		B	A	B		B		A B

A. Complete Quality Management Plan (QMP) revision – June 2005 and every 5 years thereafter
B. Prepare biennial budget initiatives for monitoring funding – Fall of odd years

RESPONSIBILITY FOR PROGRAM IMPLEMENTATION & EVALUATION

Water Division Monitoring Team

In recognition of changing data needs and evolving methodologies, WDNR is committed to evaluating its monitoring programs on a regular basis. A cross-programmatic Water Division Monitoring Team, comprised of administrators from each Bureau, Subteam leaders, and regional representatives is currently in place and will meet quarterly (or at strategic intervals as defined by the team) to evaluate the current monitoring structure and determine whether modifications are needed. The current membership of this Team will be assessed to determine whether appropriate Central Office and regional staff are involved, and to consider the addition of external agency representatives. Members of this team are expected to commit to 4-6 meetings per year, conference calls as needed, and limited but concentrated effort during biennial workplanning.

The Team Charge is as follows:

- Continue to define and improve a statewide monitoring strategy.
- Coordinate the development of Regional plans to implement the statewide monitoring strategy.
- Oversee the implementation of statewide monitoring activities.
- Report on progress with implementing the monitoring strategy.
- Coordinate staff training necessary to implement the monitoring strategy.
- Insure monitoring data entered into the Statewide Database system.

The Monitoring Team will make necessary administrative decisions, set clear expectations and timelines for the Subteams, and ensure that appropriate allocation of workplanning hours is granted by managers. Issues to be considered by the Monitoring Team may include overall effectiveness in meeting program needs, priorities for the future, emerging issues, shifts in funding, new federal or state regulations, and other issues presented by the Subteams. This Team will also be available to meet on short notice to address episodic events that require immediate assessment and action. Such emergency issues may include public health crises, hazardous spills, or other environmental emergencies. A process will be delineated for administrators to convene immediate meetings to resolve such cases.

Monitoring Subteams

The Water Division also currently has smaller Subteams in place for most resource types, comprised of technical and field staff. Subteams currently in place include Lakes, Streams, Rivers, Wetlands, Water Quality, and Groundwater. Membership on the current Subteams will be evaluated and reconstituted as appropriate, with appointment of core members for whom time will be allocated for Subteam activities. Additional Subteams will be created for Great Lakes, Data Management, and Citizen Monitoring. Subteams will meet on a regular basis for more rigorous evaluation of their programs and to set specific monitoring schedules for upcoming sampling seasons. They will be critical in providing implementation insight to the Water Division Monitoring Team, and will be expected to present proposals for modifying protocols or adopting new technologies as needed. They may consider issues related to effectiveness of current strategies in meeting data needs, identifying high-priority areas for sampling, success of staff in following delineated schedules, database development and data analysis needs, and emerging technology.

Citizen Monitoring

The WDNR is committed to using citizen volunteers to increase efficiency of data collection for use in management decisions. A Citizen Monitoring Subteam will be created to determine the most appropriate ways to incorporate this under-used resource. This Subteam will be responsible for implementing a coordinated system of citizen training to help meet WDNR monitoring needs. The long-term, committed volunteers in this program will use standard WDNR methods and protocols, and will follow monitoring designs set by WDNR monitoring staff. Initial discussion and evaluation of this concept is provided as the *Draft Citizen Monitoring Proposal* in Appendix A.

Program Management

In recognition of the need for logical program-specific oversight, certain monitoring activities were assigned to either the Bureau of Fisheries Management & Habitat Protection (FH) the Bureau of Watershed Management (WT), or the Bureau of Drinking and Groundwater (DG). Due to the need to combine resources for the sake of program efficiency, it was recognized that some monitoring activities should be co-managed by both the FH and WT programs (Table 15).

Table 15. Primary and joint program management of monitoring activities.

Fisheries & Habitat Protection	Joint FH/WT Activities	Watershed Management
Sport Fisheries Assessment (Coldwater/Warmwater/Treaty) Great Lakes & Commercial Fisheries Assessment Fish Contaminant Analysis Hatchery Compliance	Baseline – Lakes Baseline – Rivers Baseline – Streams Baseline – Wetlands Baseline – Mississippi River Long-Term Trends Water Qual. Spills & Kills Citizen Monitoring Programs	Baseline – Surface Water Quality Flow Gauging Beach Monitoring (Pathogens) L. Michigan Phosphorus Loads Total Maximum Daily Loads Stream Classification Contaminated Sediments Enforcement Nonpoint Source Assessments Point Source Effluents & Receiving Waters

Groundwater
Baseline – Groundwater Public Drinking Water Wells

Prioritization of Future Efforts

The Water Division has identified several priority program areas for enhancement should more funds become available. These priorities include: establishing a statewide volunteer coordinator, increasing TMDL 303(d) listing efforts, increasing efforts toward a formal stream classification monitoring system, and chemical analyses of waters receiving effluents from permitted entities. Additional areas for enhancement are inland beach pathogen monitoring, contaminated sediments, wetlands, and TMDL source loading monitoring. Priorities will be re-evaluated periodically and implemented as funding becomes available.

APPENDIX A.
CITIZEN MONITORING PROPOSAL

PLEASE BE AWARE: Implementing this proposal will require financial and staffing resources that the Department has not yet identified, and will be contingent on outside funding sources.

A Department team is currently working to address comments received from DNR staff and EPA regarding the proposal. In addition, this program will be integrated into a larger, Department-wide Citizen Monitoring effort. Therefore aspects of the proposal *will* change as the team works through these issues to develop a successful program.

Kris Stepenuck
Citizen Monitoring SubTeam Leader
January 27, 2005

DRAFT January 2005

To help meet the needs of shrinking state resources, both in terms of staffing and project activity funding, while meeting the ever present and growing demands for surface water monitoring, the use of citizens to assist with Department monitoring efforts has become paramount. The need to utilize citizen scientists to assist with WDNR monitoring efforts has been expressed not only within the Department, but from external partners, as well as citizens across the state. To address this need, the following draft citizen monitoring strategy has been prepared. Within it, we have sought to address a number of relevant questions and concerns related to the use of citizens as monitors for Department needs.

I. Parameters to be monitored

We reviewed the draft Water Resources Monitoring Strategy (*Strategy*) for Wisconsin to determine a number of parameters which citizens are able to be trained to safely and accurately monitor in order to assist DNR staff with monitoring as defined in DNR workplans. Because the *Strategy* was in draft form at the time of review, additional parameters that can be monitored acceptably by citizens may later be identified. Some programs identified here are still under development, thus citizen monitoring would not be able to be initiated until those programs become established, and parameters specified here are subject to change.

Citizens are able to contribute effectively to WDNR water monitoring in a multitude of ways. Areas and waterbodies in which citizen monitoring fits most seamlessly within the *Strategy* include lakes, streams, wetlands, Great Lakes and inland beach monitoring (baseline monitoring within Tier I of the *Strategy*), and management effectiveness monitoring (some components of Tier III of the *Strategy*, for instance non-point source monitoring). Targeted Evaluation Monitoring (within Tier II of the *Strategy*) also affords opportunities for citizen participation in monitoring, but each case will need to be considered individually because both parameters that are monitored and the functions citizen monitors perform will vary widely. Methods to be followed for monitoring will be pre-defined, but specific participation plans for citizens will be determined by local WDNR staff through their workplanning process, then communicated to the local citizen monitoring coordinator. Because the citizen Self-Help Lakes monitoring program is already well established, this proposal focuses on establishing citizen stream, beach, and wetland monitoring.

Parameters are suitable for monitoring by citizens to various degrees. Table 1 defines the parameters and range of monitoring participation by citizens for each of the tiers of the *Strategy*. In some cases, citizens will be able to conduct

the monitoring and obtain results in the field, but for other parameters, citizens will need to collect samples and ship the samples to a laboratory for analysis or assist WDNR staff with data collection. For certain types of sites or parameters to be measured, a range of potential monitoring participation by volunteers has been defined for the following reasons:

- Monitoring poses a safety hazard/unacceptable risk to citizen monitors
- Required training level is more rigorous than is economically feasible
- Equipment availability is limited or financial constraints are prohibitive
- Another entity already provides the monitoring (e.g., USGS flow data)
- Size of monitoring area prevents acceptable assessment by citizen monitors
- A certain level of scientific knowledge is required to make an assessment (and citizen monitors may not possess the specific knowledge that is necessary)
- Ability to measure trends is dependent on longevity of volunteer

Table 1: Range of citizen participation appropriate for monitoring parameters identified in the *Strategy*

Tier	*Monitoring Type*	*Parameter*	*Range of Participation*
I	**Streams and Rivers**	IBI	Assist WDNR staff
		Fish CPE	Assist WDNR staff
		Macroinvertebrates	Collect sample; ship to lab
		Habitat	Conduct full assessment
		E. coli	Collect sample; ship to lab
		Hardness	Collect sample; ship to lab
		D.O.	Conduct full assessment
		pH	Conduct full assessment
		Temperature	Conduct full assessment
		T.S.S.	Collect sample; ship to lab
		Ammonia	Collect sample; ship to lab
		Phosphorus	Collect sample; ship to lab
		Chlorophyll *a*	Collect sample; ship to lab
		Periphyton	TBD
		Metals (low level)	Collect sample; ship to lab
	Inland and Great Lakes Beaches	*E. coli*	Collect sample; ship to lab
		Nuisance plant growth (Cladophora; blue green algae)	Collect sample; ship to lab
		Nutrients	Collect sample; ship to lab
		Chlorophyll *a*	Collect sample; ship to lab
		Turbidity	Conduct full assessment
		Runoff control	TBD
		Water temperature	Conduct full assessment
		Air temperature	Conduct full assessment
		Rainfall	Conduct full assessment
		Velocity	Conduct full assessment
	Wetlands	Wetland classification by Eggers and Reed system	Assist WDNR staff or conduct full assessment
		Vegetation identification - diversity measured by number of different species	Assist WDNR staff or conduct full assessment

		Invasives – assessment of invasive species and estimate of trends	Collect sample; ship to lab; Assist WDNR staff; or Conduct full assessment
		Anuran survey for marshes, open water areas	Assist WDNR staff or conduct full assessment
		Breeding bird survey - Identification of territorial behavior, nest building, young, etc.	Assist WDNR staff or conduct full assessment
		Mammal survey - by tracks, sight	Assist WDNR staff or conduct full assessment
		Invertebrates - In marshes – identification to order	Conduct full assessment
	Fish Tissue/ Sediment Contam.	Concentrations of contaminants in fish tissue	Collect sample; ship to lab
II	**Use Attainability – Stream Classification**	Macroinvertebrates	Collect sample; ship to lab
		TSS	Collect sample; ship to lab
		BOD5	Collect sample; ship to lab
		Chlorophyll *a*	Collect sample; ship to lab
	Sport Fisheries Assessments	All aspects of monitoring fish	Assist WDNR staff
	Other Projects (TMDL, 303(d) lists)	Specific parameters as appropriate	Varies
III	**Nonpoint Performance Standards**	Sediments (TSS, SSC)	Collect sample; ship to lab
		Bacteria	Collect sample; ship to lab
		Nutrients	Collect sample; ship to lab
		Toxics	Collect sample; ship to lab
		Habitat	Conduct full assessment
	Management Effectiveness Monitoring	Specific parameters as appropriate	Varies

II. Data Uses for citizen-generated monitoring data

Once protocols, stringent quality assurance and quality control measures, and training have been established for a Citizen Monitoring Program, citizen-collected data have the potential to contribute to the following Clean Water Act Objectives:

- Determine water quality standards attainment
- Identify impaired waters
- Support the evaluation of program effectiveness
- Establish, review and revise water quality standards

Citizen-generated data can also be used to:

- Establish geographic trends in stream, lake, and beach quality
- Monitor water quality conditions to support TMDL/303(d) listing, integrated 303(d)/305(b) Reports, and general information on the water quality of Wisconsin waterbodies
- Monitor to assess water quality conditions in relation to nonpoint source management projects
- Assist with appropriately designating potential uses of streams in order to protect water quality in compliance with the Clean Water Act

- Determine correct Use Designations of statewide waterbodies to be used in the construction of an accurate GIS layer of stream classifications.
- Provide validation data for the stream classification system currently under development.

III. Methods

We propose that citizens be trained in the currently used, standardized Department methodologies for monitoring each of the chosen parameters. Most of these methodologies are available in the Field Procedures Manual on the WDNR intranet, and can be distributed externally. Methods that citizens would use can be grouped into four generalized categories based on the type of activity the citizens will be required to complete (Table 1):

1. Conducting field measurements or analyses
2. Collecting samples to be shipped to a certified laboratory for analysis
3. Assisting WDNR staff with field work
4. Maintaining and reporting information from a site with automated monitoring equipment

There are also a few parameters for which methods are yet to be determined.

Challenges that need to be met for citizens to be able to follow Department methods include:

- Obtaining funding to purchase equipment for the citizens to use (see section IX) that is equivalent to equipment that the Department uses (see the Field Procedures Manual on the WDNR intranet: http://intranet.dnr.state.wi.us/int/es/science/ls/fpm/2101.htm)
- Training citizens to use and maintain the equipment (see Section IV), and
- Establishing a distribution network to enable as many citizens as possible to monitor with a limited supply of monitoring equipment (see Section IX)

IV. Training

Training for the proposed citizen stream monitoring program would be developed to address each of the parameters included in the program. The WDNR currently trains its staff in these methods, thus minor modifications would need to be made to adapt the trainings to meet citizens' needs (training times, background information taught, etc.). We expect the trainings to be modeled after existing Water Action Volunteer (WAV) trainings, using full day Saturday sessions or multiple weeknight sessions. It is also expected that citizens will be able to be trained at WDNR staff trainings when citizens' schedules allow. Quality assurance and quality control measures will be discussed at each training. Follow-up trainings may be necessary to meet QA/QC plans. It will be the responsibility of the Statewide Coordinator to provide "train the trainer" sessions and to ensure that Basin Coordinators are training all volunteers to expected levels.

V. Quality Assurance/Quality Control

Because the citizen monitors will be following Department methodologies, the Department's existing Quality Management Program for monitoring each of the parameters should be able to be followed with only minor adaptations. One such modification is the need for conducting quality assurance sampling to ensure citizen collected data are equivalent to WDNR-collected data. Therefore a portion of the Quality Assurance plan for this strategy will be to define quality assurance and control checks of the samples collected by citizens (such as split samples). If necessary, an independent quality assurance project plan will be developed for the citizen monitoring program as well.

VI. Database Management

There are a variety of other databases used by the WDNR to store water monitoring data, many of which are accessible to the public via the internet. However, these systems are not linked to one another and some are not easily accessible. To unify the various database systems and more easily access data from each of them, a project is

underway to combine many of these databases as part of the new Surface Water Monitoring System (SWMS), projected to be available by the end of 2006. Efforts are underway to coordinate this citizen water monitoring proposal with SWMS development in order to ensure that data collected by citizens can be input directly to that WDNR database. In the short-term, if citizen-collected data are generated before SWMS is implemented, a simple database will be developed to hold data until they can be entered into the SWMS database.

VII. Use of Citizen-Collected Data and WDNR Response to Collected Data

To realize the efficiencies of enhancing WDNR programs with volunteer data, it is essential that citizen-collected data be evaluated and utilized in the same decision-making capacities as staff-collected data. A crucial component of such data use is the response of the WDNR to citizen findings. In the past, concerns have been raised about the lack of timely Department responses to the findings brought forth by citizen monitors. By incorporating citizen-collected data into the SWMS database, it is assumed that data from all sources (citizen and WDNR generated) will be considered as a whole when prioritizing management actions. Thus, a WDNR response to citizen findings will occur in the same time frame and manner as the WDNR is able to respond to findings of WNDR-generated findings. Training sessions for citizen monitors must incorporate information about the response to expect from WDNR to citizen-generated findings.

Another current gap—the difficulty in determining breakpoints and the WDNR response for each parameter that is monitored—is being filled through a project currently underway to determine listing criteria for 303(d) impaired waters lists. That information will be added to the overall *Strategy* when it is available, and will greatly enhance the usefulness of monitoring data collected from all sources.

VIII. Proposed Program Structure and Staffing Needs

Based on the success that the WAV program has had in using local coordinators (who are knowledgeable about local streams, fairly easily accessible to citizens, and able to coordinate local field trainings and quality assurance checks), the following structure for this citizen stream monitoring initiative is recommended: one Statewide Coordinator, 15 Basin Coordinators or 5 Regional Coordinators (either 1 per Basin or 1 per DNR Region), and a volunteer network as described below.

<u>Statewide Coordinator</u>
A full-time Statewide Coordinator's responsibilities will include, but not be limited to:

- Working with WDNR and SLOH staff to identify methods and proper QA/QC procedures for each parameter monitored in the program
- Coordinating efforts of the 15 Basin Coordinators or 5 Regional Coordinators
- Planning and conducting "train the trainer" sessions for the Basin Coordinators in all methods of the program
- Making on-site visits with Basin/Regional Coordinators for in-field training
- Preparing and disseminating program materials to Basin/Regional Coordinators and volunteers
- Working with database programmers to maintain database integrity and update as necessary
- Evaluating and modifying the program as needed

<u>Basin or Regional Coordinators</u>
Several part-time staff will be needed coordinate citizen stream monitoring efforts locally. DNR is working to determine whether 15 Basin Coordinators (one per Basin) or 5 Regional Coordinators (one per DNR Region) would be most appropriate for this proposal both in terms of available funding and program success. Responsibilities of these staff will include, but not be limited to:

- Recruiting volunteers from throughout the Basin to be monitors
- Planning and carrying out training sessions for citizen monitors
- Communicating which sites are to be monitored in a given year (as identified by internal WDNR

workgroups) and assigning appropriate monitors to each area
- Ensuring that parameters are monitored and the appropriate monitoring schedule is followed
- Collecting and entering data to the established database for the program (or verifying data that have been input to the database)
- Carrying out quality assurance and quality control assessments with citizen monitors

Volunteer Network
Each Basin will have a pool of citizen monitors coordinated locally by one of the Basin/Regional Coordinators. Local subgroups of citizens within each Basin may be asked for their assistance on a rotating basis, depending upon where in the Basin monitoring is required in a given year. Citizen monitors living nearest to waterbodies that require monitoring, or who are willing to travel (at their own expense) to defined monitoring sites would be enlisted to monitor that year. The Basin staff person will be in charge of coordinating which monitors are actively monitoring each year and providing appropriate training for active monitors.

Significant time, money and effort will go into planning these citizen monitoring efforts, therefore, citizens who participate in the program will be asked to make a commitment to the program for a minimum of 1 year. Prior to their commitment, citizens will be asked to attend an orientation session about the program, which will explain monitoring design, challenges, and expectations. They will be informed that they will be expected to monitor at designated locations and on specified dates to ensure that data that need to be collected will indeed be collected. In return, citizens will be ensured that they will receive training, equipment, and support of the WDNR in their efforts, and that the data will be utilized for purposes clearly defined prior to collection.

Initially, we propose that 4 teams of monitors per basin be formed. These teams will work in quadrants of the basin, addressing monitoring needs in those locales. Monitoring in teams will allow for cooperation among citizens to monitor on a set timeline and on specific dates while still allowing for 'life to happen'. To support these teams, 4 sets of equipment, at a minimum, will be supplied for each basin. If possible, 8-12 sets of equipment will be supplied in each basin so that monitors within a quadrant of a basin will be able to monitor various sites within a watershed simultaneously for the opportunity to collect snapshot information.

IX. Resource Allocations

A proposed budget for the Citizen Monitoring component is being developed and will be considered by the Citizen Monitoring Subteam. It is expected that grants will be available to cover costs for many of the start-up sampling equipment needs. If necessary, an independent quality assurance project plan will be developed for the citizen monitoring program as well.

Personnel
The annual budget for the citizen stream monitoring staff positions is estimated to be $4,000 per Basin Coordinator. These positions will be allocated from existing positions within each Basin. The cost estimate for the Statewide Coordinator (including benefits) is expected to be approximately $60,000 annually.

Trainings
The Statewide Coordinator will be responsible for offering Train the Trainer sessions for the 15 Basin Coordinators. Due to the variety of parameters that will be available to monitor with this program, at least two different training sessions will be offered to instruct the Basin Coordinators in proper methodologies (@$200/session). In addition, the Statewide Coordinator will carry out local in field training sessions with Basin Coordinators for QA/QC purposes.

Basin Coordinators will offer local training sessions to citizen monitors (@$200/session). It is expected that due to the variety of focus areas (i.e., Tier of monitoring and specific project being addressed) that Basin Coordinators will conduct a minimum of 3 training sessions per year (@$200/session). Thus the total budget for training sessions is estimated to be $9,400 annually.

Laboratory Services

Since citizen data will be collected in conjunction with specified WDNR work plans (no net increase in sites), costs associated with laboratory analyses will equal those already budgeted for within the Department's Water Resources Monitoring Strategy. Shipping costs for samples with time constraints for analysis should remain constant since WDNR staff would also need to use designated shipping agencies to deliver samples to laboratories. For samples without time constraints for analysis (e.g., macroinvertebrate samples), citizens will be asked to commit to delivering these samples to regional WDNR offices from which the samples can be delivered to laboratory destinations by office staff or WDNR delivery truck at a later time and without added cost.

If citizen groups wish to monitor sites other than those scheduled by the WDNR monitoring team, the data may be incorporated into WDNR databases if proper protocols are followed. However, the citizen groups may be responsible to supply funds to cover costs for both shipping and laboratory analyses for these sites.

Travel, Supplies and Equipment

(**Note:** Calculations presented below are based on 15 Basin Coordinators. If 5 Regional Coordinators are used instead, this budget will change. This will be determined by the Department Team addressing comments received regarding this proposal.)

Having the ability to travel statewide or within a Basin is essential for job duties to be carried out effectively by the Statewide and Basin Coordinators. The annual budget allocation for travel is estimated to be $16,447.50. This includes mileage (1500 miles @ 32.5 cents/mi), lodging ($62/night for 5 nights), and meals ($34/day for 5 days) for each Basin Coordinator and mileage (3000 miles @ 32.5 cents/mi), lodging ($62/night for 10 nights), and meals ($34/day for 10 days) for the Statewide Coordinator.

Supplies including postage and photocopying are estimated to cost $500 per Basin and Statewide Coordinator, totaling $8000/year. Materials production for the statewide effort is budgeted at $3000 per year.

Costs for equipment purchases will be outlined below, but it should be noted that these costs can likely be covered using grant funds. To initiate the program, 4 equipment 'kits' per basin will be supplied to citizen monitoring teams by the WDNR. However, it is recommended that this equipment supply be supplemented in future years based on experiences within the WAV program that indicate that there is better long term success of volunteer monitoring efforts when equipment is very accessible to citizens. That is, equipment is available at a location that is only a short drive from a monitor's home or monitoring site and there is enough equipment available for citizens to be able to monitor when their schedules allow. In short, this means that the more monitoring equipment there is available, the more data volunteers will be able to collect. In addition, as mentioned in section VIII (Volunteer Network), more equipment in a basin can allow for snapshot (same time at multiple locations) sampling to be conducted within a single watershed.

Table 2 outlines equipment that will be necessary to carry out field sampling and monitoring and costs associated with the purchase of 60 (@4 per basin) of each item. Equipment lists were obtained from the WDNR Field Procedures Manual (http://intranet.dnr.state.wi.us/int/es/science/ls/fpm/2101.htm) and WDNR Guidelines for Evaluating Habitat of Wadable Streams.

Table 2. Equipment costs for 15 basins with 4 kits per basin.

Parameter	*Item*	*Supplier*	*Cost each*	*Cost for 60*
Habitat	Measuring Tape	Forestry Suppliers #39972	$45	$2700
	Flagging Tape	Forestry Suppliers #57905	$1	$60
	Clipboard	Forestry Suppliers #53282	$22	$1320
	Meter Sticks	Fisher #S32052	$6	$360
	Waterproof Paper	J. Darling Corp. 208511 (bulk cut;500); 8511 (copier sheets;200)	$50	$3000
	Forest Densiometer	Forestry Suppliers #43888	$100	$6000
	Map Measurer	Forestry Suppliers #45251	$70	$4200
Macroinvertebrates	Aquatic nets	Forestry Suppliers #77921	$122	$7320
	Storage jars		$10	$600
D.O./Temperature/Conductivity	High Quality Meter	Forestry Suppliers (YSI85)	$1250	$75,000
pH	High Quality Meter	Forestry Suppliers (YSI60)	$800	$48,000
T.S.S./SSC/Ammonia/Phosphorus/Chlorophyll *a*/ metals/ Hardness/*E. Coli*/ algae/ BOD_5	Equipment (i.e., bottles) costs included in lab analyses charges			---
Turbidity	Portable Turbidity Meter	HF Scientific:EW-05559-00	$1100	$66,000
Rainfall	Use existing gages			----
Water flow	High Quality Meter		$1200	$72,000
All aspects of monitoring fish	No additional costs to utilize volunteers			---
TOTAL				**$286,560***

* It is expected that a significant portion of the equipment costs for start-up of the citizen monitoring component could be obtained through grants. These grants are not likely, however, to cover personnel and training costs.

X. Summary

Citizens can be effectively used to support the WDNR in its surface water monitoring efforts. They are capable of collecting valid and accurate information and can provide a cost-effective—though not cost-free—service to the Department. In order to implement this proposal, it must be assessed in its entirety and appropriate changes and recommendations should be made to address concerns of reviewers. Then, following revisions to the document, steps should be taken to obtain funding and staff to support the project. The goal for this proposal is to implement a pilot project(s) in spring 2006.

APPENDIX B. GLOSSARY

303(d)	List of impaired waters, required by Clean Water Act section 303(d) and submitted by states to EPA biennially
305(b)	Water Quality Assessment Report to Congress, required by Clean Water Act section 305(b) and submitted by states to EPA biennially
ATRI	Aquatic and Terrestrial Resources Inventory
AVM	Acoustic Velocity Meter
AWQ	Ambient Water Quality
BEACH Act	Beaches Environmental Assessment and Coastal Health Act
BMP	Best Management Practice
CDX	Central Data Exchange
CPE	Catch Per unit Effort
CSREES	Cooperative State Research, Education, and Extension Service
CWA	Clean Water Act
EMAP	Environmental Monitoring and Assessment Program
EMP	Environmental Management Program
ERSC	Environmental Remote Sensing Center (University of Wisconsin)
FHR	Fish Habitat Rating
FQA	Floristic Quality Assessment
FQI	Floristic Quality Index
GLFC	Great Lakes Fisheries Commission
GET	Gamefish/Endangered/Threatened species
GIS	Geographic Information Systems
GPS	Global Positioning System
HTML	HyperText Markup Language
IBI	Index of Biotic Integrity
ISS	Integrated Science Services (WDNR)
LTRMP	Long Term Resource Monitoring Program
LTT	Long Term Trend site
NEIEN	National Environmental Information Exchange Network
NTU	Nephelometric Turbidity Units
PCB	Pychlorinated Biphenyls
QA/QC	Quality Assurance/Quality Control
QMP	Quality Management Plan
RPD	Rlative Percent Difference
SFR	State Fish Restoration
STORET	STOrage and RETrieval System (EPA)
Strategy	WDNR's *Water Resources Monitoring Strategy*
SWMS	Surface Water Monitoring System (WDNR)
TLS	Trained Local Sampler Program
TMDL	Total Maximum Daily Load
TSF	Trophic Status Index
UMRS	Upper Mississippi River System
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

USGS	United States Geological Survey
UWEX	University of Wisconsin - Extension
WADRS	Waterbody Assessment Display and Reporting System (WDNR)
WAV	Water Action Volunteers
WBIC	Waterbody Identification Code
WDNR	Wisconsin Department of Natural Resources
XML	Extensible Markup Language