CITIZEN MONITORING AS WATERSHED MANAGEMENT TOOL

Reesa Evans
Lake Specialist
Certified Lake Manager
Adams County LWCD

Setting Up Monitoring

When looking at setting up a monitoring program, the first step is to decide the purpose of the monitoring. The purpose will determine what types of data will be needed. It can also usually determine the length of time data collection needs to occur. It may also help determine where data collection should occur.

In many instances, there are citizen monitoring programs available that will help a watershed group obtain needed data for a watershed plan with little financial investment.

The next column shows just some of the citizen monitoring programs that can collect useful data that I can't cover in this presentation. Most are always looking for citizen volunteers.

Bats/Owls

Bumble Bees

Bird Counts/Breeding

Carnivores & Mammals

Clean Boats, Clean Waters

Fish Catch/Spawning

Frogs/Toads/Turtles/Salamanders

Furbearers/Forest Wildlife

Habitat Assessment

Loon Watch

Native Mussels & Sponges

Project Budburst (leafing/flowering/fruiting)

Rare Plants

Snapshot Wisconsin

Wetlands

WHY MONITOR WATER QUALITY?

Here are some reasons to regularly monitor water quality:

(1) To establish baseline data;

(2) To track trends or changes in the water quality;

(3) To document chronic or episodic events;

(4) To provide information for resource management;

(5) To determine success (or lack of) of management actions;

(6) To identify specific existing or emerging water quality problems;

(7) To gather information for prevention or remediation steps;

(8) To respond to emergencies;

(9) To educate the public about water quality.

CITIZEN LAKE MONITORING

Over 1000 Citizen Lake Monitoring (CLMN) volunteers currently measure water clarity, using the Secchi Disk method, as an indicator of water quality. Many also collect chemistry, temperature, and dissolved oxygen data, as well as identify and map plants or watch for the any new sites of aquatic invasives in their waterbodies, esp. near boat landings.

The “Big Three” actions for lake monitoring water quality are:

1. Measuring water clarity by using a Secchi disk;
2. Taking a water sample of the water column to be tested for total phosphorus;
3. Taking a water sample of the water column to be tested for chlorophyll-a.

CLMN

The Wisconsin Department of Natural Resources provides training and the equipment for taking water clarity and temperature readings free of charge. It also pays for 4 lab samples per year that cover costs for testing for total phosphorus and chlorophyll-a in samples taken in the deep hole of a lake. This means that if a lake has one or two volunteers to do this sampling, important data can be gained for the lake free of any financial charge and with little time spent (less than an hour each time).

The data is stored in the Surface Water Integrated Monitoring System (SWIMS). Volunteers can be authorized to enter their own data in some instances. The State Hygiene Lab also automatically enters testing results for total phosphorus and chlorophyll-a in SWIMS. Annual reports and graphs for each sample site are also available on this website. Anyone can view the data on the website, but not everyone can enter data.

http://dnr.wi.gov/topic/surfacewater/swims/

CLMN Field Documentation Sheet

State of Wisconsin
Department of Natural Resources

Wisconsin Citizen Lake Monitoring Network – Secchi & Chem
Form 3200-099 (R 1/15)

Notice: Information is collected under s. 33.02, Wis. Stats. Personally identifiable information, including names of volunteers, will be broadly distributed in conjunction with lakes data.

Station ID # (use separate form for each site)	Lake Name	County	Year

Names of each volunteer who sampled on each date	**Date** Use 4 digits, e.g., May 19 is 0519	**Time** Round to nearest hour	**Secchi Depth** Round to nearest quarter of a foot	**Hit Bottom** Yes No	**Lake Level** High Low Normal	**Appearance** Clear Murky	**Water Color** Blue; Green; Brown; Red; Yellow	***Perception** 1 - 5	**Date Entered**
Observations:									
Observations:									
Observations:									
Observations:									
Observations:									

Date:

Depth	Temp. F	D.O. mg/L

Date:

Depth	Temp. F	D.O. mg/L

Date:

Depth	Temp. F	D.O. mg/L

Date:

Depth	Temp. F	D.O. mg/L

***Perception** = Perception of the amount of algae in the water at your sample location:

1=Beautiful, could not be any nicer.
2=Very minor aesthetic problems; excellent for swimming and boating enjoyment.
3=Swimming and aesthetic enjoyment of lake slightly impaired because of high algae levels.
4=Desire to swim & level of enjoyment of lake substantially reduced because of algae; would not swim, but boating is OK.
5=Swimming and aesthetic enjoyment of lake substantially reduced because of algae levels.

If you enter the data on the web, keep a copy for your records. There's no need to mail a paper copy. Otherwise mail the original (blue) copy in the postage paid envelope (or to Citizen

Sample Lake Annual Report

Wolf Lake - Deep Hole 2016 Results

Wolf Lake - Deep Hole was sampled **8** different days during the 2016 season. Parameters sampled included:

- **Water Clarity**
- **Temperature**
- **Total Phosphorus**
- **Chlorophyll-a**

The average summer (July-Aug) secchi disk reading for the Wolf Lake Deep Hole was 14.0 feet. The average for the Central Georegion was 9.1 feet. Typically the summer (July-Aug) water was reported as **CLEAR** and **BLUE**.

Chemistry data was collected on Wolf Lake Deep Hole. The average summer Chlorophyll-a was 2.0 µg/l (compared to a Central Georegion summer average of 12.8 µg/l). The summer Total Phosphorus average was 12.8 µg/l. Natural lakes that have more than 20 µg/l and impoundments that have more than 30 µg/l of total phosphorus may experience noticeable algae blooms and nuisance aquatic plant growth.

Secchi Disk Use in Monitoring

To test water quality by evaluating a lake's clarity, a Secchi disk is used. This is an 8-inch weighted disk marked with black and white triangles.

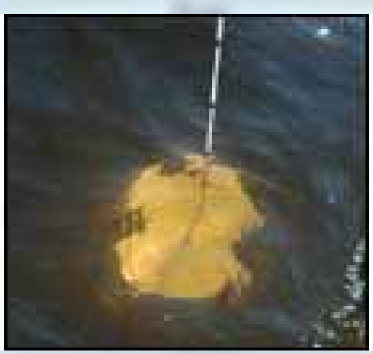
Secchi readings can be affected by things like(1) suspended sediment & other solids in the water; (2) wind speed & direction; (3) sun or clouds in sky; (4) algae density; (5) water color; (6) recent disturbance of the bottom; (7) presence of aquatic plants.

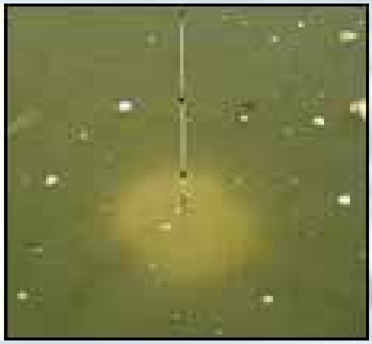
There are many purposes for which a reading might be useful, such as after a storm event or after a busy holiday weekend.

Secchi Disk--2

Secchi disk measurements also indicate the depth at which a lake has enough oxygen to support fish and plant life. The general rule is that sunlight can penetrate the water about 1.7 times the depth of a Secchi disk reading. Thus, if the Secchi reading is 10 feet, the sunlight can penetrate the water to about 17 feet deep.

Secchi disks also keep track of any changes in water color or clarity. Some lakes may look brown due to tannic acid. There are also often seasonal changes due to algae blooms that can cause lake water to turn very green, brown, orange, or even purple. Disturbances can also cause a color change. Keeping track of these color changes and of variations in Secchi depth allows for a better understanding of a lake.





Phosphorus

The CLMN also may use testing for total phosphorus. In Wisconsin, most lakes are phosphorus-limited: this means that it is the element in the lowest supply vs. the demand for it. So changes in the phosphorus levels are likely to have significant effect on the water quality of the lake.

Under some conditions, excess phosphorus can cause algae to “bloom”, i.e. grow out of control. The phosphorus level in a lake also greatly affects the occurrence & growth density of aquatic plants.

Phosphorus--2

Lakes have both dissolved and particulate forms of phosphorus. Dissolved phosphorus is biologically available to plants & algae for growth. Particulate phosphorus is “bound up” chemically and isn’t immediately available to plants & algae. However, changes in conditions can cause this phosphorus to be released, when it can then be used by aquatic plants & algae. Lake phosphorus can come from agricultural runoff, lawn runoff, human & animal waste, erosion, impervious surface runoff, internal loading, etc.

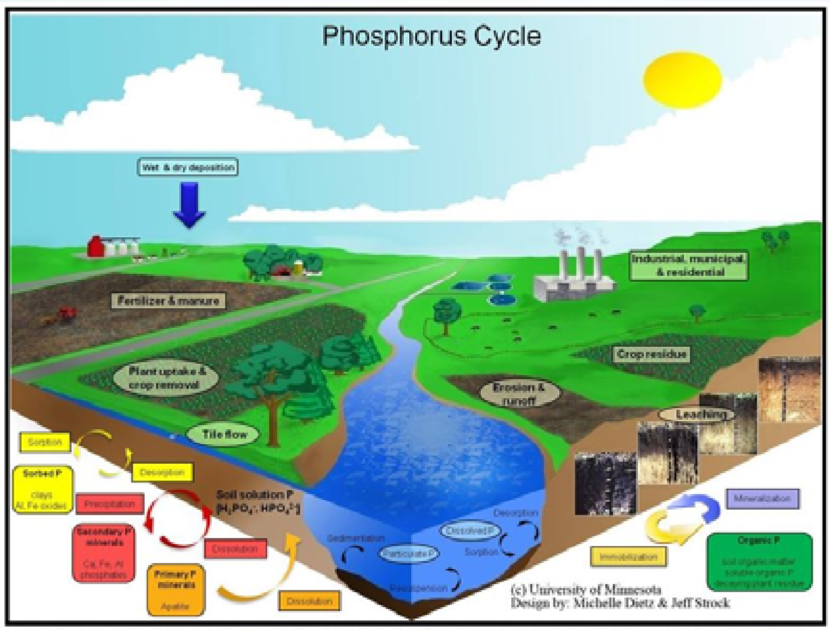
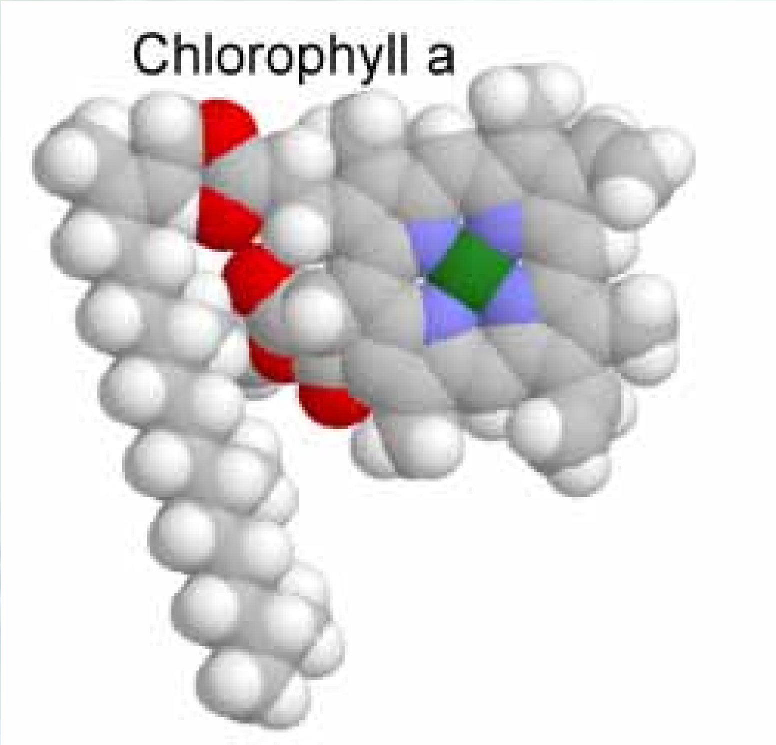


Figure 3: Phosphorus Cycle. P naturally cycles in different forms in the environment. However, human have accelerated the movement of phosphorus by mining and land-applying phosphate fertilizers, land applying organic soil amendments, and discharging concentrated sources of P directly into water bodies. Source: *http://swroc.cfans.umn.edu/ - reprinted with permission.*

Chlorophyll-a



The third criteria tested is chlorophyll-a. This pigment is found in all green plants & algae, causing their green color. Studies have shown the level of chlorophyll-a present correlates well to the amount of algae a lake has. This type of testing does not determine what kind of algae is present; instead, it gives an amount of total algae present.

The amount of water filtered for this testing is proportional to the Secchi disk reading of that day. If the Secchi reading for that day is under 1 foot, only filter 50 ml of water. If it is 1 foot to 1.5 feet, filter 100 ml. For anything over 1.5 feet, filter 200 ml.

Water Temperature

Water temperature is measured at various levels by using a digital probe, a measured cable and a small digital meter that records temperature. The cable has depth marks for convenience.

Temperature exerts a major influence on biological activity and growth in lake water. It determines the kinds of organisms that can live in the water.

Fish, insects, zooplankton, phytoplankton, and other aquatic species all have a preferred temperature range. As temperatures get too far above or below this preferred range, the number of individuals of the species decreases until finally there are none.

Water Temperature--2

Temperature also influences water chemistry. The rate of chemical reactions generally increases at higher temperatures. At higher temperatures, water, especially groundwater, can dissolve more minerals from the rocks it is in and will therefore have a higher electrical conductivity. The opposite reaction occurs when considering a gas like oxygen dissolved in the water. Cold water can hold more of the oxygen than the warm water. Since warm water holds less oxygen than cold water, some aquatic life can't survive as well in warm water as in cold water. Also, due to chemical reactions, some chemical compounds are more toxic to aquatic life at higher temperatures.

All of this data (Secchi depth, TP, Chl-a, temp) is stored in the WDNR's Surface Water Integrated Monitoring System (SWIMS), so it is accessible to anyone who wants to examine it.

Using Sample Results

Trophic State	Quality Index	Phosphorus	Chlorophyll-a	Sechhi Disk
		(ug/l)	**(ug/l)**	**(ft)**
Oligotrophic	Excellent	Less than 1	Less than 1	Over 19
	Very Good	1 to 10	1 to 5	8 to 19
Mesotrophic	Good	10 to 30	5 to 10	6 to 8
	Fair	30 to 50	10 to 15	5 to 6
Eutrophic	Poor	50 to 150	15 to 30	3 to 4
Hypereutrophic	Very Poor	over 150	Over 30	Less than 3

Trophic States

Secchi disk readings, total phosphorus levels, and chlorophyll-a levels are used to determine a lake's "trophic status". This is a measure of a lake's nutrient enrichment, on a scale of 0 to 100, with 100 being the most nutrient rich lake possible. There are three main categories of nutrient enrichment: Oligotrophic; Meso-trophic; Eutrophic.

Good: Oligotrophic lakes have clear, deep water with few algal blooms. Larger game fish are often found in such lakes.

Fair: Mesotrophic lakes have more aquatic plant and algae production, with occasional algal blooms and a good fishery. The water is usually not as clear as that of oligotrophic lakes.

Poor: Eutrophic lakes are very productive, with lots of aquatic plants and algae. Algal blooms are often frequent in these lakes. They may have a diverse fishery, but rough fish (such as carp) are also common. Water is often cloudy or murky. Small shallow lakes are more likely to be eutrophic.

Stream Monitoring

Wisconsin also has a citizen-based stream monitoring program called Water Action Volunteer Program (WAVE). This program has three levels of participation for citizen scientists: Level 1; Level 2; and Level 3. Volunteers collect data to increase public understanding of watersheds, to help educate about the impact of humans on stream quality, and to build a baseline of water quality information in the state's wadeable streams. Equipment and lab fees are covered by the WDNR, as is training for all levels.

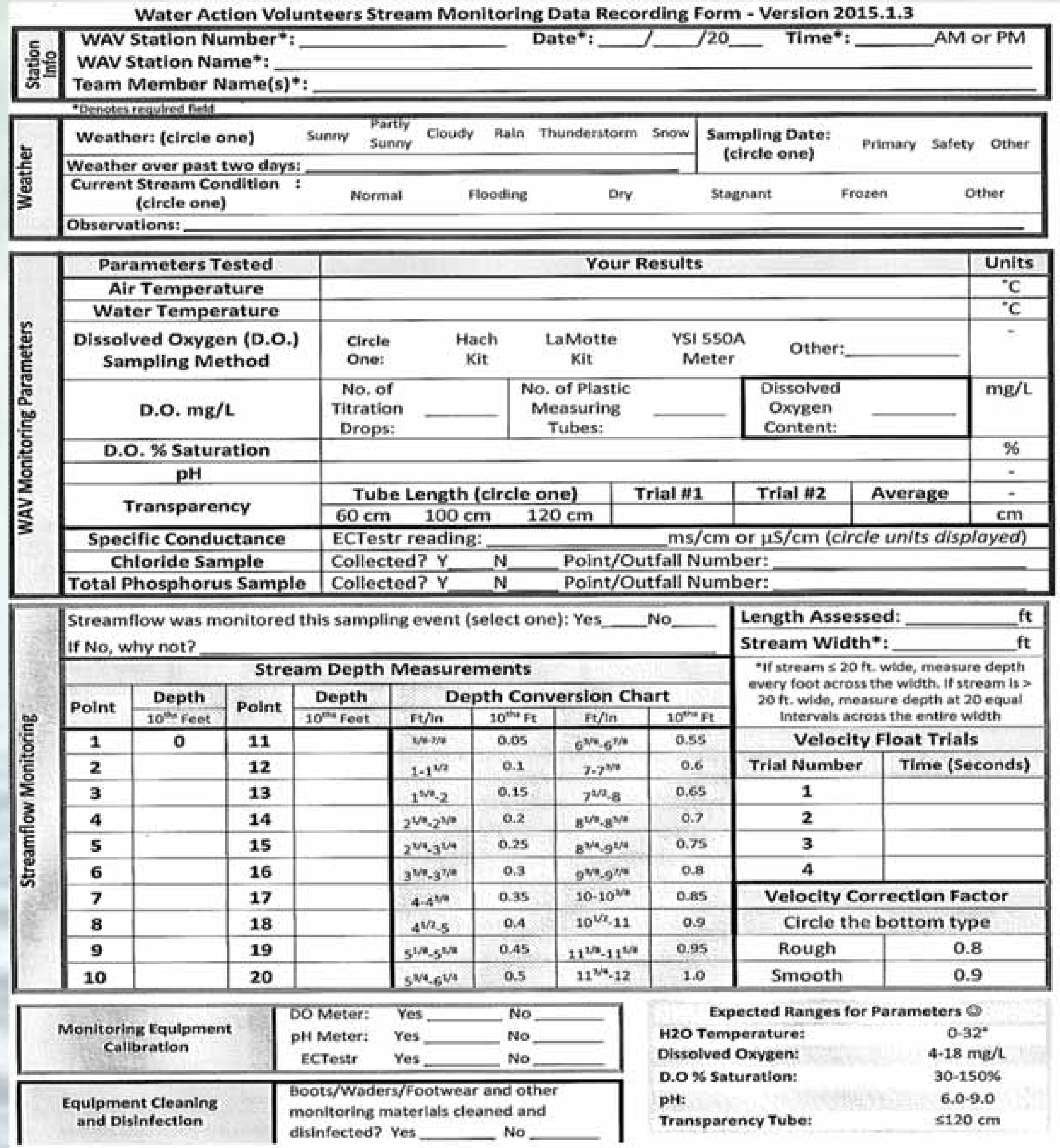
Stream Monitoring--2

Level 1 water quality indicators monitored monthly by volunteers in streams of Wisconsin include dissolved oxygen, pH, temperature, transparency, stream flow, habitat, macroinvertebrates, specific conductance, chloride, total phosphorus, and E. coli. Macroinvertebrates are monitored in spring and fall, and habitat is assessed once per year in summer.

In Status and Trends Monitoring (Level 2), dissolved oxygen, pH and transparency are monitored monthly between April (or May) and October on predetermined dates. In some instances, testing for total phosphorus is added. Level 3 monitoring is connected to Special Projects.

The data is stored in SWIMS. Volunteers can be authorized to enter their own data in some instances. The State Hygiene Lab also automatically enters testing results for total phosphorus in SWIMS from stream testing.

WAVE Documentation Sheet



Water Action Volunteers Stream Monitoring Data Recording Form - Version 2015.1.3

Station Info

WAV Station Number*: ____________ Date*: ___/___/20___ Time*: ________AM or PM

WAV Station Name*: ____________

Team Member Name(s)*: ____________

*Denotes required field

Weather

Weather: (circle one)	Sunny	Partly Sunny	Cloudy	Rain	Thunderstorm	Snow	Sampling Date: (circle one) Primary Safety Other
Weather over past two days: ____________							
Current Stream Condition : (circle one)	Normal	Flooding	Dry	Stagnant	Frozen	Other	
Observations: ____________							

WAV Monitoring Parameters

Parameters Tested	Your Results					Units
Air Temperature						°C
Water Temperature						°C
Dissolved Oxygen (D.O.) Sampling Method	Circle One:	Hach Kit	LaMotte Kit	YSI 550A Meter	Other:______	-
D.O. mg/L	No. of Titration Drops: ______		No. of Plastic Measuring Tubes: ______	Dissolved Oxygen Content: ______		mg/L
D.O. % Saturation						%
pH						-
Transparency	Tube Length (circle one): 60 cm 100 cm 120 cm		Trial #1	Trial #2	Average	- cm
Specific Conductance	ECTestr reading: ______ms/cm or µS/cm (*circle units displayed*)					
Chloride Sample	Collected? Y____ N____ Point/Outfall Number: ______					
Total Phosphorus Sample	Collected? Y____ N____ Point/Outfall Number: ______					

Streamflow Monitoring

Streamflow was monitored this sampling event (select one): Yes____No____

If No, why not? ____________

Length Assessed: ____________ft

Stream Width*: ____________ft

*If stream ≤ 20 ft. wide, measure depth every foot across the width. If stream is > 20 ft. wide, measure depth at 20 equal intervals across the entire width

Stream Depth Measurements

Point	Depth (10ths Feet)	Point	Depth (10ths Feet)	Depth Conversion Chart Ft/In	10ths Ft	Ft/In	10ths Ft
1	0	11		$3/8$-$7/8$	0.05	$6^{3/8}$-$6^{7/8}$	0.55
2		12		1-$1^{1/2}$	0.1	7-$7^{3/8}$	0.6
3		13		$1^{5/8}$-2	0.15	$7^{1/2}$-8	0.65
4		14		$2^{1/8}$-$2^{3/8}$	0.2	$8^{1/8}$-$8^{5/8}$	0.7
5		15		$2^{3/4}$-$3^{1/4}$	0.25	$8^{3/4}$-$9^{1/4}$	0.75
6		16		$3^{3/8}$-$3^{7/8}$	0.3	$9^{3/8}$-$9^{7/8}$	0.8
7		17		4-$4^{3/8}$	0.35	10-$10^{3/8}$	0.85
8		18		$4^{1/2}$-5	0.4	$10^{1/2}$-11	0.9
9		19		$5^{1/8}$-$5^{5/8}$	0.45	$11^{1/8}$-$11^{5/8}$	0.95
10		20		$5^{3/4}$-$6^{1/4}$	0.5	$11^{3/4}$-12	1.0

Velocity Float Trials

Trial Number	Time (Seconds)
1	
2	
3	
4	

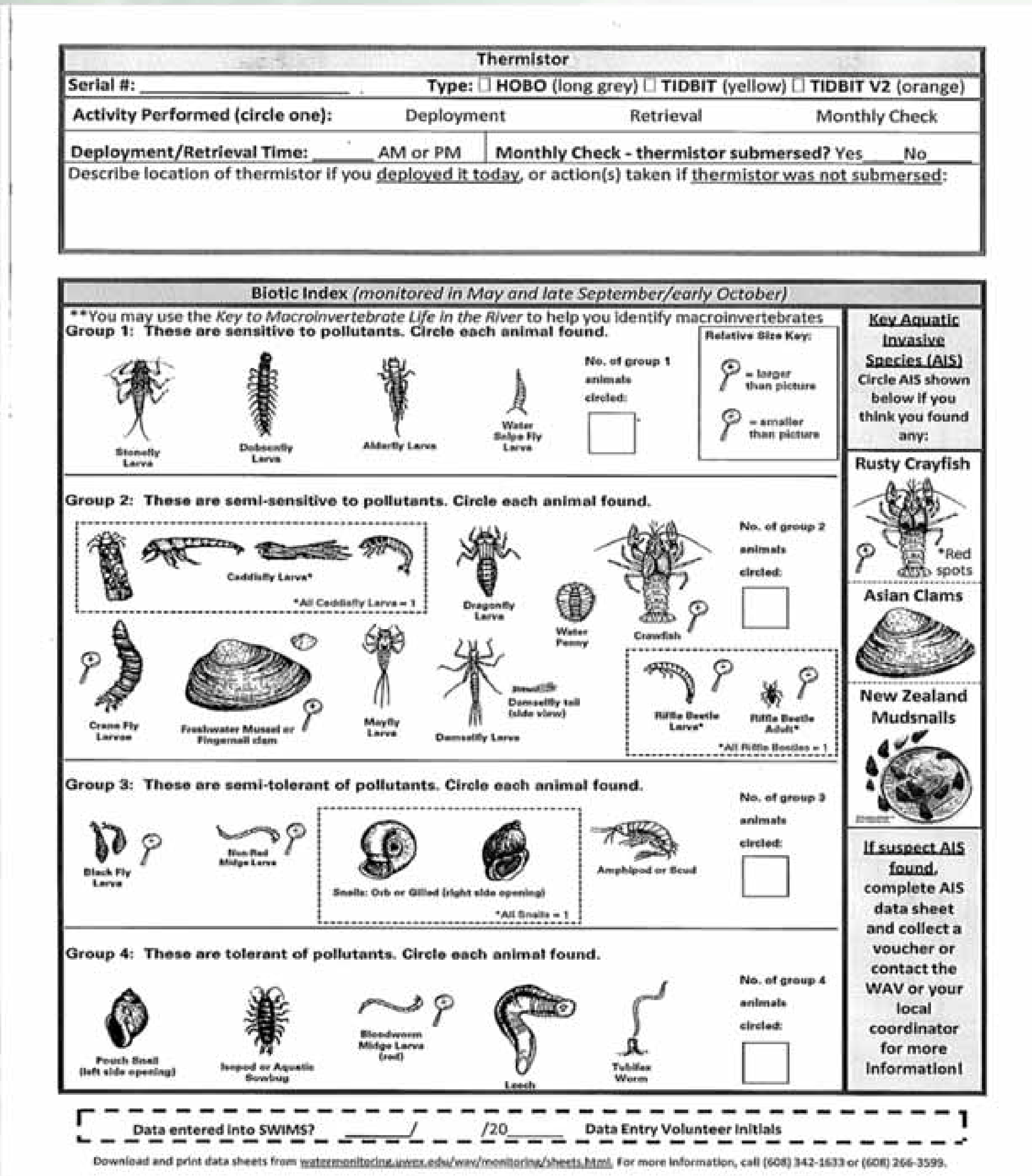
Velocity Correction Factor

Circle the bottom type	
Rough	0.8
Smooth	0.9

Monitoring Equipment Calibration	DO Meter: Yes ______ No ______	
	pH Meter: Yes ______ No ______	
	ECTestr Yes ______ No ______	
Equipment Cleaning and Disinfection	Boots/Waders/Footwear and other monitoring materials cleaned and disinfected? Yes ______ No ______	

Expected Ranges for Parameters ☺

H2O Temperature:	0-32°
Dissolved Oxygen:	4-18 mg/L
D.O % Saturation:	30-150%
pH:	6.0-9.0
Transparency Tube:	≤120 cm



Thermistor

Serial #: ____________________ Type: ☐ HOBO (long grey) ☐ TIDBIT (yellow) ☐ TIDBIT V2 (orange)

Activity Performed (circle one): Deployment Retrieval Monthly Check

Deployment/Retrieval Time: ______ AM or PM | Monthly Check - thermistor submersed? Yes____ No____

Describe location of thermistor if you deployed it today, or action(s) taken if thermistor was not submersed:

Biotic Index *(monitored in May and late September/early October)*

**You may use the *Key to Macroinvertebrate Life in the River* to help you identify macroinvertebrates

Group 1: These are sensitive to pollutants. Circle each animal found.

Stonefly Larva, Dobsonfly Larva, Alderfly Larva, Water Snipe Fly Larva

No. of group 1 animals circled:

Relative Size Key: = larger than picture; = smaller than picture

Group 2: These are semi-sensitive to pollutants. Circle each animal found.

Caddisfly Larva* (*All Caddisfly Larva = 1), Dragonfly Larva, Water Penny, Crawfish, Crane Fly Larvae, Freshwater Mussel or Fingernail clam, Mayfly Larva, Damselfly Larva, Damselfly tail (side view), Riffle Beetle Larva*, Riffle Beetle Adult* (*All Riffle Beetles = 1)

No. of group 2 animals circled:

Group 3: These are semi-tolerant of pollutants. Circle each animal found.

Black Fly Larva, Non-Red Midge Larva, Snails: Orb or Gilled (right side opening) (*All Snails = 1), Amphipod or Scud

No. of group 3 animals circled:

Group 4: These are tolerant of pollutants. Circle each animal found.

Pouch Snail (left side opening), Isopod or Aquatic Sowbug, Bloodworm Midge Larva (red), Leech, Tubifex Worm

No. of group 4 animals circled:

Key Aquatic Invasive Species (AIS)

Circle AIS shown below if you think you found any:

Rusty Crayfish (*Red spots)

Asian Clams

New Zealand Mudsnails

If suspect AIS found, complete AIS data sheet and collect a voucher or contact the WAV or your local coordinator for more information!

Data entered into SWIMS? ______/ /20______ Data Entry Volunteer Initials

Download and print data sheets from watermonitoring.uwex.edu/wav/monitoring/sheets.html. For more information, call (608) 342-1633 or (608) 266-3599.

Caddisfly Larvae

Red Midge Worm

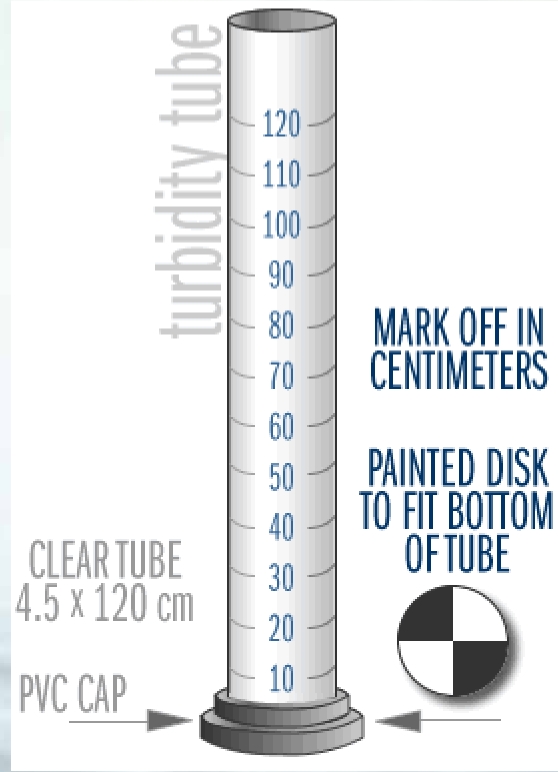
Leech

Stream Monitoring--Report

Typical Stream Site Report

Fieldwork Start	**09/15/2015 11:25 AM**
Fieldwork End	09/15/2015 11:50 AM
Project(s)	Carter Creek at CTH G
Data Collectors	Michelle Harrison
Fieldwork Event Status	COMPLETE
Field Sample ID	
Station Org.	21WIS
Station ID	10013259
Station Name	Carter Creek (Cc-2 DS of CTH G)
Station Type	RIVER/STREAM
Station WBIC	1351200
Station Waterbody Name	Carter Creek
Field Description	
Report To	
Report To DNR User ID	
Report to EPA?	Y
Comments	very high all year - no flow

AMBIENT AIR TEMPERATURE FIELD	26.2 C
DISSOLVED OXYGEN FIELD	2.27 MG/L
OXYGEN, DISSOLVED, PERCENT OF SATURATION %	23.40%
Additional Comments	no flow but water level is high
Transparency tube length (cm)	120 CM
Water Temperature	17.3 C
Transparency Tube Measurement 1	120 cm
Transparency Tube Measurement 2	120 cm
Average Transparency	120 cm
Dissolved Oxygen Sampling Method?	YSI 550A Meter
Number of Group 1 animals circled:	0
Number of Group 2 animals circled:	0
Number of Group 3 animals circled:	1
Number of Group 4 animals circled:	0
Total Animals	1
Group 1 Value	0
Group 2 Value	0
Group 3 Value	2
Group 4 Value	0
Total Value	2
Macroinvertebrate Index Score	2
Snails (Orb or gilled right side opening)	present
Weather Over the Past 2 Days	sunny & warm



AIS MONITORING

It is also important to monitor each water body for aquatic invasive species. Invasive species are known to cause both environmental and economic damages of various types. Environmental damages are difficult to quantify, but those verified include:

- Loss of habitat for native species
- Decrease/extinction of native species
- Displacement of native species
- Alteration of ecosystem processes like energy, nutrient & water cycling, changes in the food web, changes in community structure
- Hosting of diseases harmful to native species and/or humans
- Reduction of plant health & productivity, including changes in biodiversity that decrease system’s ability to withstand further invasions

AIS MONITORING--2

AIS MONITORING--3

More easily quantified is the economic cost of invasive species. Economic costs include cost of water treatment (chemical, harvesting, etc.), interference with power generation, damage to commercial and/or sport fishing, damages to industrial facilities, damage/interference with recreational activities, and decline in waterfront property values.

Economic costs estimates vary widely. A publication in 2008 estimated cost of over $200 million/year just in the Great Lakes.

One of the most widely-quoted studies is a 2005 paper from Cornell University estimating a cost of over $130 Billion per year for dealing with invasive species in the U.S. An article in 2012 estimated the cost in Wisconsin at over $100 Million in the Great Lakes States. Dealing with spiny water fleas in Lake Mendota resulted in costs of $80-$163 Million in damages.

A report from the US Fish and Wildlife Service estimated that invasion of Eurasian Watermilfoil reduced waterfront property values by 16% in Vermont & 13% in Wisconsin.

As noted, water quality monitoring can evaluate the physical, chemical, and biological characteristics of a waterbody in relation to human health, ecological conditions, and designated water uses.

Watershed monitoring is wider and more comprehensive approach to data collection that incorporates water quality as well as watershed conditions. It provides data for the evaluation of the water resource(s) while also resulting in information to help establish cause-and-effect relationships.

While baseline data can be used to quantify water quality and describe ecological characteristics or processes within the water body or watershed, longer term, repeated sampling helps to evaluate past and present protection measures and target areas for improvement.

Regular Long-Term Water Quality Monitoring

Regular long-term water quality monitoring can therefore be useful in watershed management for:

- Documenting watershed condition and water quality trends over time
- Screening for potential water quality problems
- Determining whether water bodies meet regulatory standards and/or support designated uses (safe for swimming, drinking, fishing, etc.)
- Providing data for scientifically-based watershed management decisions
- Determining the impacts of discharges (sewage treatment plants or industries) to support appropriate effluent limits
- Determining the impacts of land use activities (farming, forestry, or urban development)
- Supporting management of water quality-limited waters, including assessment of Total Maximum Daily Loads (TMDLS)
- Educating the watershed’s citizens, leaders or users

Questions? To Contact Me

Reesa Evans Certified Lake Manager Lake Specialist
Adams County Land & Water Conservation Department

revans@co.adams.wi.us

Mailing: P.O. Box 287
Friendship, WI 53934
Main office: 608-339-4268

Street: 402 Main Street
Friendship, WI 53934
Direct Line: 608-339-4275

Website: www.adamscountylwcd.net

Resources You Might Use

Barden, E. No date. Why citizen science for water quality. https://terra.nasa.gov/citizen-science-water-quality.

Borman, S., R. Korth & J. Temtle. Through the looking glass: a field guide to aquatic plants. UW-Extension.

Shaw, B., C. Mechenich & L. Klessig. 1993. Understanding lake data. UW-Extension.

Skawinski, P. Aquatic plants of the Midwest. Self-published.

Aquatic Plant Identification Websites:

aquaplant.tamu.edu/database/index.htm

www.dnr.state.mn.us/shorelandmgmnt/apg/index.html

aquat1.ifas.uf.edu/node/600

www.dgif.virginia.gov/fishing/weedid

www.ecy.wa.gov/programs/wq/links.plant.html

www.botany.wi.edu/wisflora

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