Wisconsin River Basin

Clean Waterways Project

Photo credit: UW Stevens Point

May 2015

Updates on the Wisconsin River TMDL and water quality improvement efforts.

Water quality efforts underway

There is a major effort underway to improve water quality in the Wisconsin River Basin. The framework for this effort is a Total Maximum Daily Load (TMDL), which is the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards. A waterway that exceeds water quality standards is often no longer suitable for its designated uses, such as wildlife habitat, fishing, or other recreational activities.

A TMDL requires several years of monitoring data to determine where the pollutants are coming from. This data is then combined with computer models to determine how reductions can be made fairly and in the most cost-effective way possible. Wisconsin has a number of TMDLs that are either in the development phase or have already been completed and are in the process of being implemented. The Wisconsin River TMDL is currently under development and scheduled to be finalized in 2017.

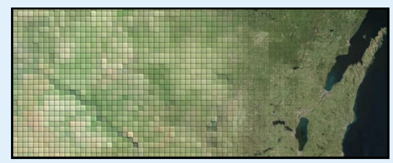
Photo credit: DNR historic photo archive [exit DNR]

Through this newsletter, the Wisconsin River TMDL team is working to communicate progress on the different stages of TMDL development and invite public feedback. This quarterly newsletter also highlights information, tools and resources available to help with conservation efforts in the state.

Subscribe to receive email updates about the Wisconsin River TMDL.

Created by Susan Sandford - Wisconsin Department of Natural Resources Bureau of Water Quality

IN THIS ISSUE

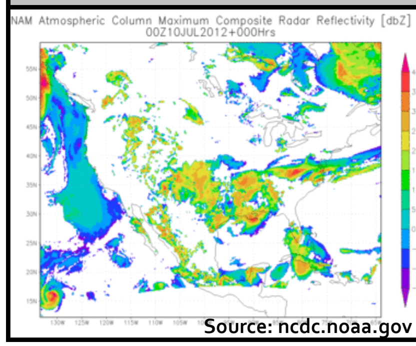


Wisconsin River Basin Modeling

By: Aaron Ruesch and Dave Evans, Wisconsin Department of Natural Resources

What is a computer simulation model?

Computer models are used to forecast the weather.



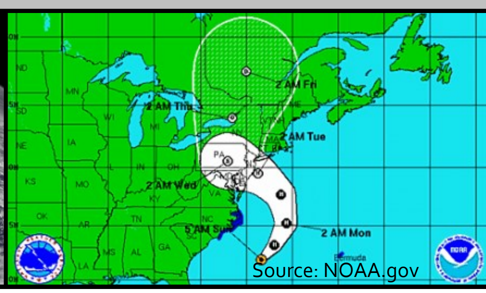
Source: ncdc.noaa.gov

Basically, a computer simulation model is a set of equations and/or algorithms that describe the behavior of an interconnected system. Many people don't realize it, but they rely on computer simulation models in their daily lives. Weather forecasts, for example, are models that many of us rely on every day.

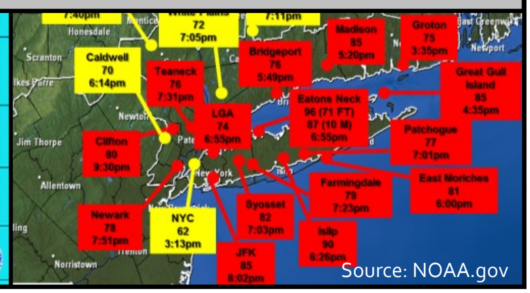
As we all know, the weather forecasters don't always get it right. This is because weather is dependent on a complex system which is rather difficult to represent with equations and algorithms. These complex variables include: solar radiation, terrestrial radiation emission, topography, pressure gradients, sea surface temperatures, ocean currents, and jet stream behavior, among others. However, sometimes weather forecasts are spot-on. For example, the location and timing of landfall of Hurricane Sandy were predicted correctly 8 days in advance!

The correct location and timing of landfall of Hurricane Sandy was predicted 8 days in advance using computer models.

Source: NASA.gov



Source: NOAA.gov



Source: NOAA.gov

Computer model simulations of early human ancestors.

Source: sciencenews.org

Computer models can help us respond more quickly and be better prepared for future weather events. In addition to predicting the future, models can be used to help reconstruct the past when complete information is not available. For example, we did not have photography in our early evolutionary history, so we will never know precisely what our early human ancestors looked like. However, we can create simulations of our evolutionary ancestors based on the limited information we have, such as bones and artifacts.

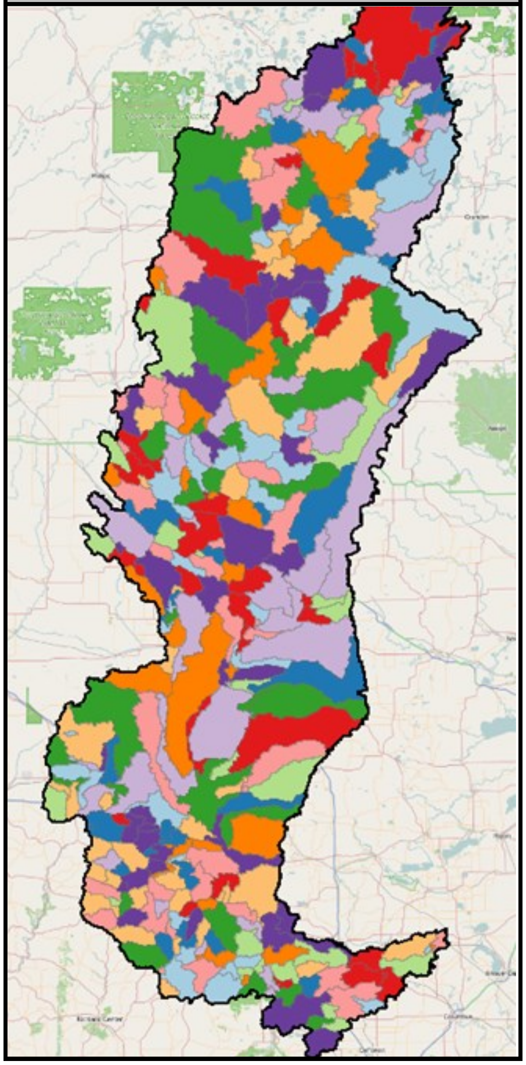
Computer model simulations can help us reconstruct the past (e.g. proto-humans) and forecast the future (e.g. weather).

Applying these ideas the Wisconsin River TMDL modeling process

In the Wisconsin River, our primary goal is to accurately simulate daily streamflow and monthly averages of sediment and phosphorus loads entering the river and its tributaries. We will estimate these variables at 337 locations over a period of 12 years from 2002 through 2013. The 337 locations are the pour points of 337 subbasins nested within the overall upper Wisconsin River basin. Each subbasin is outlined in the map to the next page.

Before we can estimate streamflow, sediment, and phosphorus, we need to set up the model so that it closely simulates what is actually happening in the basin. To accomplish this task we have various datasets containing information about the past that have been compiled from monitoring water quality or gathered through observations of other physical or human processes, for instance weather observations or agricultural censuses. We can use these pieces of information to reconstruct

Wisconsin River Subbasins



the details of the past in places where we have no observations. This reconstruction helps us understand the physical and chemical processes of the system, which will ultimately aid in management efforts for improving water quality.

In this way, the Wisconsin River TMDL watershed model is similar to reconstructing the look of proto-humans, but we're not interested in nearly that level of detail. The TMDL model contains generalizations of the landscape within the watershed and its effects on water quality. Using our proto-human analogy, it would be more like reconstructing parts of a skull, rather than extrapolating to a realistic organism with skin, hair, eyes, etc. where we have little information other than what we look like now to inform the reconstruction.

Model setup and parameterization

We are currently in the model setup and calibration phase of TMDL development. Specifically, we are right on the cusp between setup and calibration. We have just completed our initial ***parameterization*** of the simulation model. A good way to understand parameterization is to think about it in terms of fishing. When you go fishing, there are a number of factors, or parameters, that can affect your probability of success (these are the same factors we often blame when making excuses about why we didn't catch anything). Some examples of these factors are listed in the table below.

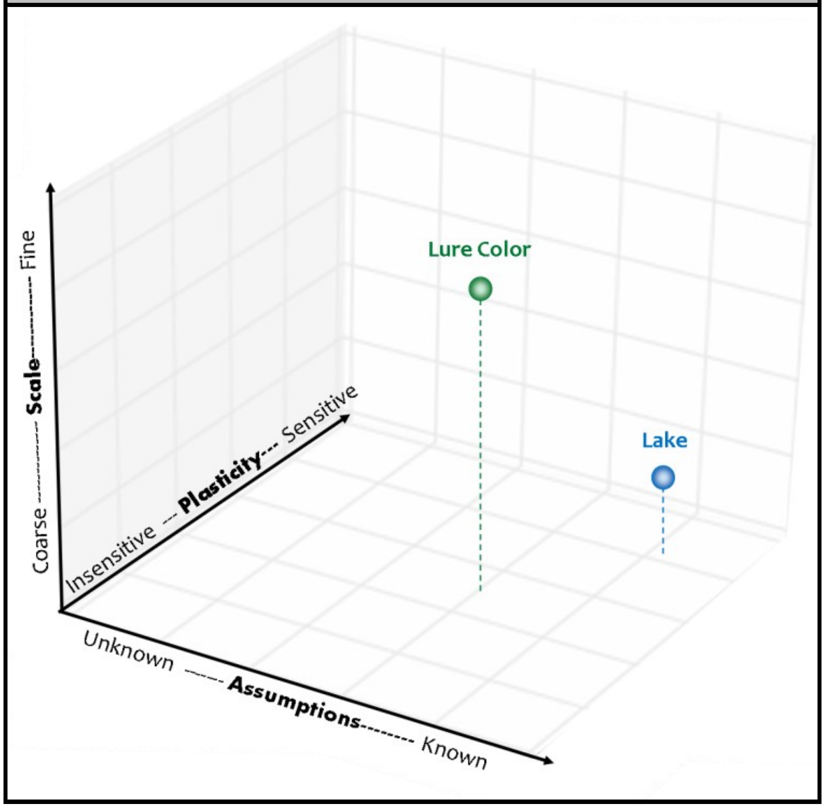
Fishing Success Parameters
Type of lure/bait/fly
Weather (cloudiness, rain, prior runoff events, barometric pressure, approaching front)
Fishing location (weedy flat, steep drop-off)
Time of day
Presentation (knots, type of line, fishing depth, timing)

These factors can all contribute to why you did or didn't catch a fish. In the same way all these parameters impact the probability of a successful fishing trip, there are a number of interacting parameters that impact water quality. Actually, there are a TON of parameters! The table below shows just a few overarching categories of parameters that impact streamflow, sediment, and phosphorus, and therefore water quality and quantity. Within each of these parameters are many more specific details that need to be considered. For example, fertilizer—is it synthetic or organic? Is it surface applied or injected? Is it liquid or solid? What is the chemical composition? How often is it applied? Just like in fishing, all these parameters interact to affect the water quality in the river.

Water Quality Outcome Parameters		
Soils	Wind	Geology
Precipitation	Agriculture	Fertilizer
Urban	Springs	Wastewater

In addition to identifying the parameters, we also think about each in a number of different ways. In a model, we can think of parameters spanning gradients of assumptions, scale, and plasticity. For example, (1) some things are unknown and others are known with a high level of precision and accuracy (*assumptions*), (2) some pieces of information are rather coarse and others are fine, in dimensions of space and time or data precision (*scale*), and (3) some parameters are insensitive in the model whereas others strongly impact the outcome (*plasticity*).

Model Parameterization: fishing example

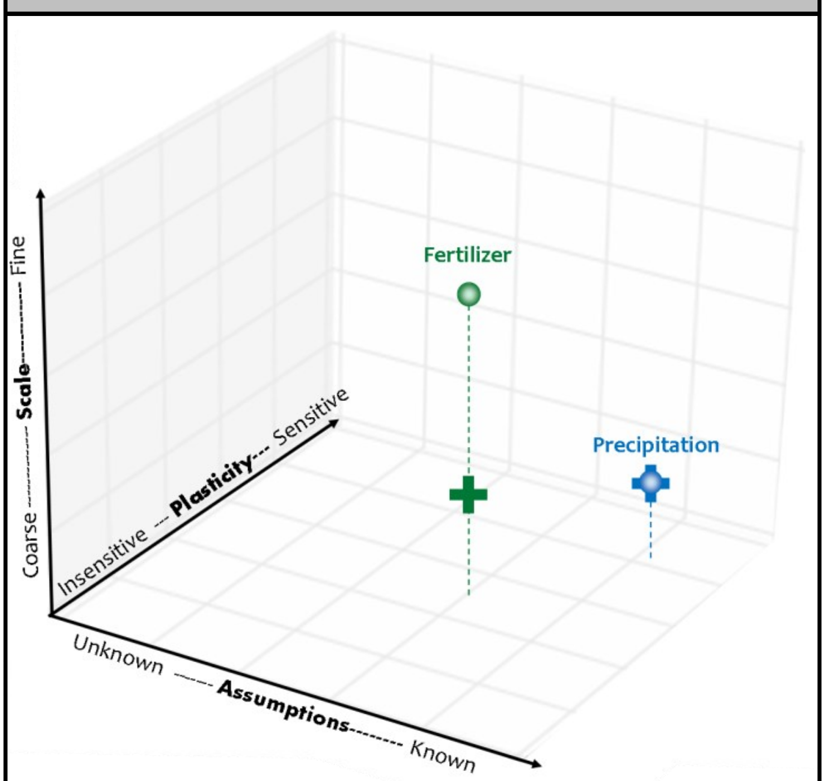


Using our fishing analogy as an example, we can look at parameters of **lake** and **lure color** (*figure on right*). We may know with a very high degree of certainty that there are a lot of easily catchable fish in the lake that we decide to fish on (*assumptions*). And perhaps the selection of lake strongly impacts our success (*plasticity*). It may be an area where there is only one good lake to fish on. And finally, the selection of the lake is relatively coarse in *scale*, whereas fine level information would be which shoreline to fish within the lake. Similarly, we can look at lure color choice, which is a fine detail (*scale*), sometimes it makes a big difference, sometimes not (*plasticity*), and we know with a fair degree of certainty which colors work (*assumptions*).

We think about water quality models in much the same way but replace the "lake" and "lure color" parameters with those that affect water quality and quantity, such as **precipitation** and **fertilizer use** (*figure below*). We have good information about precipitation (*assumptions*) at sparsely located stations (*scale*), and the amount of precipitation strongly impacts the model (*plasticity*).

Fertilizer is highly detailed information (*scale*), and we understand how it's used by surveying the agricultural community (*assumptions*), and sometimes it affects water quality, sometimes not (*plasticity*).

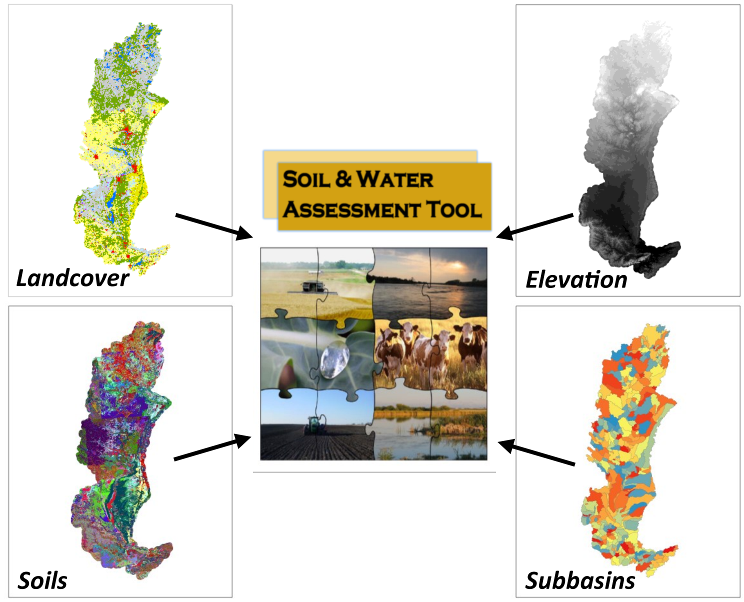
Model Parameterization: water quality example



When thinking about how these parameters fit within the model, it's also important to note that the level of information we use must match the scale of analysis. So, for instance, for the Wisconsin River TMDL, we don't need very fine field/farmer-level information about fertilizer. This level of detail would be washed out in the averages when we aggregate up to larger subbasins and average to a monthly time-step. Coarse information is reasonable to use for the fertilizer parameter (*as indicated by the* + *in the figure to the left*). However, the precipitation data that we've recorded from weather stations matches just about perfectly, so no level of aggregation or subsetting is needed (*as indicated by the* + *in the figure to the left*).

Modeling, like fishing, can sometimes be tricky conceptually. We need to pay attention to all of the interacting parameters and ensure that the information contained in each parameter is appropriate to the model and the project as a whole.

Model assembly



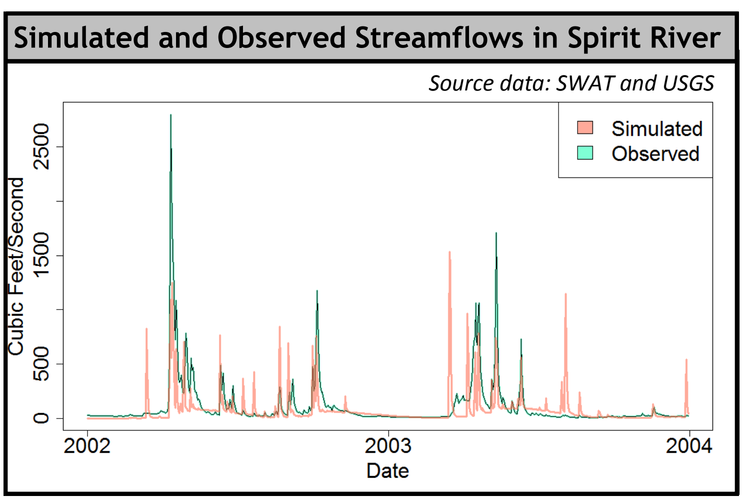
One of the models we are using to develop the TMDL is the Soil & Water Assessment Tool (SWAT), which uses key parameters (soil type, elevation, land cover) to simulate many different processes occurring on the landscape. SWAT is a widely accepted model that has been around for a long time, and improved alongside advances in scientific understanding. It is open source meaning that all of the equations and underlying code are available to the public. The process of creating and editing these different data layers for use in the model is called ***model configuration or model assembly***.

Model assembly is an important phase of model development because it ensures that the data being used reflects the actual landscape conditions as closely as possible. For example, the DNR used landcover data, interpreted from satellite images, and combined it with information provided by county-level experts and land managers to ensure that we have a detailed and complete picture of the land management in the basin. More information about this process is described in our November 2014 newsletter.

Model calibration

The DNR is just about to begin the model calibration phase of the Wisconsin River TMDL development process. Put simply, ***model calibration*** involves taking the existing model, with all the interconnected pieces, and bringing it into focus so that it better matches reality.

The figure below shows simulated and observed streamflows in the Spirit River. Using this as an example, model calibration is the process of making adjustments until the simulated flows of the model match the real world observed flows. You can see from the figure that there are several peaks in the simulated flow that do not align well with real world observation data. This means that some parameters need to be adjusted until the simulated line more closely matches the observed line. This is a complex process because there are many different parameters in the model that affect streamflow. To figure out which parameters need to be changed, we use a technique known as sensitivity analysis.



Sensitivity analysis is a useful first step in the calibration phase and allows us to determine which parameters we should be interested in and how we should change them. Going back to the fishing analogy, we could test 100 different lures on the same day, at the same time, at the same depth, on the same lake, etc. to find out if the type of lure matters and how it impacts our outcome. Next, we could test 100 different fishing depths, using the same lure, at the same time, on the same lake, etc. to find out how different depths impact our outcome.

For the SWAT model, there are hundreds of different parameters, but the most important ones for this project are those relating directly to hydrology, including groundwater, soil, and stream channel parameters. Once we have completed the sensitivity analysis, we can use the results as a general guide when we choose how to adjust the model parameters. The model fit between the observed data and simulated data is assessed both visually and statistically and is determined to be calibrated once it meets certain criteria.

Once the models are calibrated we can validate and refine them and move into the TMDL allocation phase. During the model development process, the DNR is providing opportunities for stakeholder input. Turn to page 6 to read more about this collaborative effort and how to access the draft models.

Technical Project Updates

Technical Timeline: where are we at?

Land Use and Land Management Inventory/Mapping

☑ Fused together the best available land cover maps and integrated an extensive survey of agricultural crop rotations and management. More information about this process is described in our November 2014 newsletter.

Wastewater Database and Monitoring QA/QC

☑ Reviewed and compiled monitoring data for delivery to contractors (UW-Stout, EPA, USGS).

⇨ Compiling other monitoring data as needed.

Watershed and Urban Model Setup and Calibration

☑ Obtained and reviewed surface water effluent load information from basin engineers and compiled into Access database.

⇨ Working with wastewater staff to compile info on facilities that intake river water, so loads can be adjusted accordingly.

⇨ Working with wastewater staff to determine loadings from general permits.

While DNR is setting up and calibrating the model, our partners are working on:

Load Calculations (USGS)

⇨ USGS is currently using the flow and water quality monitoring data from 38 sites to calculate pollutant loads.

BATHTUB Reservoir Modeling and Reservoir Sediment Modeling (UW-Stout)

☑ Have completed the lake water chemistry data reduction, examined seasonal variations to identify the appropriate averaging period, and explored inter-annual variations in May to September averaging period metrics.

⇨ Future work: incorporate tributary loading, calibrate steady-state model to observed total phosphorus, forecast chlorophyll and Secchi transparency, and run phosphorus loading reduction scenarios.

CE-QUAL-W2 Reservoir Modeling (EPA/Limnotech)

☑ Assessed model segmentation provided by Army Corps to DNR, and documented that segmentation matches capacity curves provided by DNR. Reviewed GIS information provided by DNR. Reviewed water quality and flow data and began development of database. Initiated set-up of water quality models.

To learn more about the modeling progress and to see a timeline of the process, click HERE

Wisconsin River TMDL development open and collaborative effort!

A number of stakeholders in the basin have requested the opportunity to access and comment on TMDL models concurrently with their development. In response to these requests, the DNR is making a strong effort to be open and collaborative regarding the details of the TMDL models and is posting all of the computer programming scripts written as part of the model dataset development process on the GitHub website [exit DNR] where anyone can access and view our activity in real time. GitHub is part of the open source software movement, founded on the principle that everyone should have access to the underlying bits and pieces of how software works. In addition to making scripts available online, in January, the DNR released Wisconsin River TMDL draft models-in-progress via an FTP link sent out to the Wisconsin River TMDL GovDelivery list, giving stakeholders a chance to review draft models and provide comments and feedback to the DNR. The time and effort led to a productive conversation on the Wisconsin River TMDL, and will lead to a better, more robust end product.

For additional information on accessing draft TMDL models-in-progress, contact dnrwisconsinrivertmdl@wisconsin.gov. An outline of the plan and estimated schedule for technical stakeholder input is available HERE.

5th Annual Wisconsin River Water Quality Improvement Symposium

Making Connections for Clean Water

The fifth annual Wisconsin River Water Quality Improvement Symposium took place on March 19 at the University of Wisconsin - Stevens Point. The symposium provides updates on the Wisconsin River Basin Clean Waterways Project, a water quality monitoring effort designed to improve conditions in the Wisconsin River, and a collaborative effort between many partners including UW-Stevens Point and Wisconsin Department of Natural Resources. This year's symposium, themed ***Making Connections for Clean Water***, brought together representatives from municipalities, industry, agriculture, government, nonprofits, academia and citizen organizations to discuss water quality improvement efforts in the Wisconsin River basin.

Throughout the day, symposium attendees were able to get updates about the status of water quality improvement efforts, learn about innovative technologies and computer models that are helping that effort, and hear about how social science data can help to shape the process. Attendees were also able to learn from examples of creative solutions being used in other areas and think about how similar projects and programs could be implemented in the Wisconsin River basin. This included an inspiring talk by keynote speaker Mark Cupp about the 25 years of history and accomplishments in the Lower Wisconsin State Riverway, an overview of a water quality trading project in Sparta Wisconsin that is continuing to grow and evolve as it works to reduce phosphorus, and a county perspective on the exciting projects happening in the Red Cedar River watershed, including the establishment of farmer led councils, a water quality fund and an innovative civic governance process.

A total of 125 people attended this year's symposium, representing 19 different counties in Wisconsin.

Comments from participants:

"Improving water quality in the Wisconsin River basin should be a priority because it took everyone to help make the problem and we need everyone to do their part to clean it up."

"Hearing the backgrounds and interests of the many stakeholders really opened my eyes to the diverse and unique concerns of everyone involved."

Presentations from this year's symposium are available **HERE**

What Role do Lake Organizations Play in Improving Water Quality?

Summary of a panel discussion at the Wisconsin Lakes Partnership Convention

Each year the Wisconsin Lakes Partnership Convention brings together citizen scientists, businesses, and lake, river and wetland professionals to interact, learn, share and engage with one another to ensure a healthy future for our waters. This year, the Wisconsin DNR hosted a panel of lake organization representatives to discuss the important role that lake organizations play in achieving water quality protection and improvements. The citizens that belong to lake organizations do so because they care about the current and future health of the lake. The reasons for this range from living on the lake, visiting the lake for family vacations, having a hotel or restaurant near the lake that depends on visitors to stay in business, as well as numerous other reasons. Whatever the reason, these citizens have united under a common goal of protecting the lake they love.

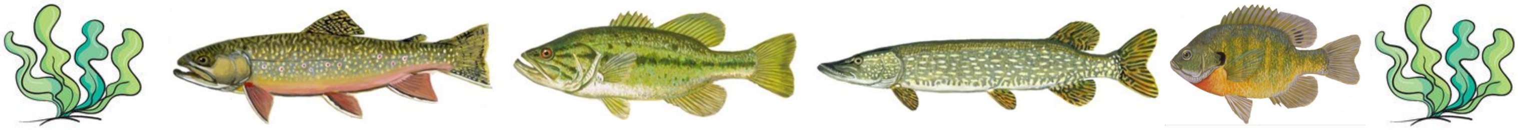
Each group has its own unique history and experiences and the panel discussion at this years convention allowed other citizens to learn from their accomplishments. The panel featured representatives from three lake associations within the Wisconsin River basin, as well as the River Alliance, which supports citizen groups working on water quality issues.

Each panelist discussed the work their group is doing and we have provided a summary of this discussion below:

Lake Wisconsin Alliance - *Kirk Boehm (President)*

For years, Kirk has been concerned about the impacts that poor water quality could have on Lake Wisconsin and was on the lookout for a citizen group that he could join, but none existed. Knowing that others in the community were also concerned about water quality, Kirk decided to take the initiative and bring people together to talk about forming a group. After several of these discussions and planning meetings, the Lake Wisconsin Alliance officially formed and had its first annual meeting in August 2014. It currently has around 60 members and continues to grow. This group is still in the early stages of its efforts and is currently holding education sessions every six to eight weeks to increase awareness in the community about water quality issues. They are also in the process of applying for grants and developing a website and promotional materials to be able to more effectively communicate their messages.

For more information on the Lake Wisconsin Alliance, visit their ***Facebook page*** *[exit DNR].*



Fish illustrations by Virgil Beck

Lake Wausau Association - *Russ Graveen (President) and Rick Parkin (Vice President)*

The Lake Wausau Association has existed since 1988, but was reinvigorated in 2010, after a meeting with the Rib Mountain Business Association in which they discussed the impact that Lake Wausau has on its four surrounding municipalities. Since then, they have received numerous grants and grown to over 200 members. They have put a lot of effort into reaching out to and educating people that don't live directly on the lake and their membership reflects that with 30-40 percent non-riparian members. They are currently finishing up a three year study and working with the Army Corps of Engineers, Wisconsin DNR, and University of Wisconsin to write a lake management plan detailing what can be done to clean up the lake and reduce the phosphorus load. One of their biggest challenges has been maintaining and fostering new relationships with members within and outside of the community. This is key because achieving water quality improvements depends on awareness and participation from the broader community.

For more information on the Lake Wausau Association, visit their ***website*** *[exit DNR].*

Petenwell & Castle Rock Stewards - *Rick Georgeson (President)*

The Petenwell and Castle Rock Lakes are the second and fifth largest inland lakes in Wisconsin and bring a great deal of tourism and recreation opportunities to the surrounding communities. During the summer months, both lakes have experienced many days of blue-green algae blooms that have negatively affected recreational use of the lakes and the income of businesses around the lake. Wanting to do something about the lakes they love, a number of citizens, government agencies, and local businesses formed the Petenwell and Castle Rock Stewards (PACRS) in 2006-2007. PACRS followed a similar path as other groups, holding educational meetings for the local community to increase citizen awareness about algae and water quality. They have also put a lot of effort into reaching out to other groups and individuals in the area to talk about ways to partner together. PACRS members have attended listening sessions with their legislators and have invited them out to the lakes to see the water quality issues first hand. They make an effort to meet with other lake groups and tour facilities, such as the Neenah Paper Company, to gain a better understanding of how other groups and facilities operate. They also invite groups, such as farm organizations and industrial dischargers, to attend and present at their monthly meetings so that both groups can better understand the work and issues that are important to the other. Fostering these opportunities has allowed PACRS to have productive conversations with other groups about how they can work together to improve water quality.

For more information on the Petenwell and Castle Rock Stewards, visit their ***website*** *[exit DNR].*

River Alliance of Wisconsin - *Matt Krueger (River Restoration Program Director)*

The River Alliance's Wisconsin River Initiative provides tailored support for citizen advocacy groups in the Wisconsin River basin with the goal of creating a network of organized citizens whose engagement shapes the environmental policies that affect the river. The support River Alliance provides includes technical assistance on issues of science, policy, advocacy, and organizational development. These are all tools that citizen groups need to develop in order to become effective advocates for their river resources.

River Alliance has worked with all three of the groups represented in the panel discussion, as well as numerous others within the watershed. This help has ranged from helping with group formation, to assistance coordinating public outreach events, to citizen group summits that allow the groups to come together to share ideas and learn techniques to be more effective in their efforts.

For more information on the River Alliance, visit their ***website*** *[exit DNR].*

Tools and Resources

Conservation Toolbox:

Modeling and Analysis Tools for Nonpoint Source Implementation

There are a number of models available to assist with nonpoint source implantation planning, evaluation and reporting. Click HERE to learn about these tools and how they can be used to help prioritize conservation efforts.

A Citizen's Guide to Watershed Planning

This guide [exit DNR] provides information to assist with writing and implementing a watershed plan.

Crop Cover Economics Decision Support Tool

As cover crops gain attention and focus, questions are moving from the agronomic to the economic. A spreadsheet partial budgeting tool [exit DNR] is available to help address some of the economic and financial questions that arise. This tool is designed to help producers, landowners, planners and others make informed decisions when considering adding cover crops to their production system.

Become a Citizen Scientist

Join Wisconsin's Citizen-Based Water Monitoring Network [exit DNR] to learn more about Wisconsin's water resources and help improve water quality. There are a number of opportunities and projects that you can become a part of, including stream or lake monitoring, aquatic invasive species education, river clean ups and storm drain stenciling, among many others.

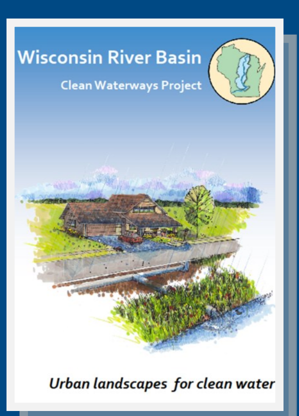
The Citizen Lake Monitoring Network is a part of this program that focuses specifically on lakes. The goal is to educate and empower volunteers, collect high quality data, and to share this data and knowledge. Data collected by volunteers includes water clarity, chemistry, temperature, dissolved oxygen data, invasive species monitoring, as well as identifying and mapping plants.

To date, the data collected by citizen scientists has been used in lake assessment and planning efforts, requests to the Wisconsin Legislature for phosphorus water quality standards and funding for invasive species projects, as well as reports to the federal government about trends in Wisconsin lakes and further needs. Click HERE to learn more about how this valuable data is used.

Reduce your impact: *Rainscape your yard!*

As spring rains fall on Wisconsin, it's a great time to think about ways each and every one of us can help protect our beloved water resources.

Rainfall runs off of roofs, sidewalks, driveways, streets and compacted lawns. The water then flows into the street, down the storm drain, and through the storm sewer to the nearest stream, river or lake. Along the way it picks up pollutants, such as fertilizer, grass clippings, sediment, pet waste, oil, heavy metals, bacteria and a number of other contaminants. This untreated stormwater degrades water quality.



You can help prevent these pollutants from reaching storm drains and streams by incorporating rainscaping practices into your landscape and following a few other simple pollution prevention practices.

Find out more in our *Urban Landscapes for Clean Water* brochure. Want to make an even bigger impact? Share this information with your friends and neighbors.

Image credit: RainscapingIowa.org

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