Phosphorus:
Lessons from 10+ Years of Numeric Standards for Wisconsin's Waters

2023 Phosphorus Conference Report

UW System Water Policy Network

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Center for Water Policy
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A. Report Authors

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B. Executive Summary

Wisconsin passed some of the nation's earliest and most comprehensive phosphorus regulations in 2010. Phosphorus pollution poses a significant threat to the health and stability of Wisconsin's waters. Excess phosphorus runoff to surface waters produces an ecological imbalance that leads to nuisance or harmful algal blooms, fish kills, and human illness. Waterbodies impaired by phosphorus pollution threaten public health, reduce recreational use, and decrease property values.

Phosphorus: Lessons from 10+ Years of Numeric Standards for Wisconsin's Waters was a statewide conference held in February 2023 to evaluate the past decade of Wisconsin's phosphorus regulatory implementation and assess the rules' impact on water quality. This report provides an overview of the conference goals, identifies conference planning committee members, co-hosts, and sponsors, and summarizes the key lessons from each panel presentation.

This report includes an academic research agenda with research gaps and questions for University of Wisconsin System researchers to study and answer in the next decade. This report also contains policy recommendations for reducing phosphorus pollution and improving water quality in Wisconsin. Finally, enclosed in this report is a

bibliography of phosphorus research sources synthesized from the University of Wisconsin System and beyond.

C. Conference Description

Phosphorus: Lessons from 10+ Years of Numeric Standards for Wisconsin's Waters was a retrospective on Wisconsin's phosphorus rules where key stakeholders came together to evaluate the implementation and impact of Wisconsin's phosphorus regulations. This conference connected academic researchers with professionals working on water issues, agricultural and conservation professionals and agencies, farmers and producers, policymakers, and the public. The conference featured academic research and case studies to foster discussion around policy mechanisms that address the ongoing challenge of phosphorus pollution. The goal of this conference was to help inform a future research agenda and shape future policy on phosphorus management in Wisconsin.

D. Conference Planning Committee

1. Tyler Byrnes, Nelson Institute for Environmental Studies, UW-Madison
2. Cody Calkins, Conservation Specialist, Division of Agricultural Resource Management, DATCP
3. Matt Claucherty, Phosphorus Implementation Coordinator, Water Quality Bureau, WDNR
4. Kevin Fermanich, Professor & Researcher, UW-Green Bay
5. Ken Genskow, UW-Extension Specialist and Professor of Environmental Planning & Policy, UW-Madison
6. Marilyn Wiseman, Assistant Director, Center for Water Policy, School of Freshwater Sciences, UW-Milwaukee
7. Anya Janssen, Water Policy Specialist, Center for Water Policy, School of Freshwater Sciences, UW-Milwaukee
8. Jason Knutson, Wastewater Section Chief, WDNR
9. Eric Olson, Director, Extension Lakes, UW-Stevens Point

10. Zach Raff, Associate Professor of Economics, Social Science Department, UW-Stout
11. Adena Rissman, Vilas Distinguished Achievement Professor of the Human Dimensions of Ecosystem Management, Department of Forest and Wildlife Ecology, College of Agricultural and Life Sciences, UW-Madison
12. Melissa Scanlan, Lynde B. Uihlein Endowed Chair in Water Policy, Professor, and Director of the Center for Water Policy, School of Freshwater Sciences, UW-Milwaukee
13. Sara Walling, Senior Policy Manager for Agriculture and Restoration, Alliance for the Great Lakes
14. Brian Weigel, Division Administrator, Division of Agricultural Resource Management Nutrient Management Policy, Partnerships, and Innovation, DATCP

E. Co-Hosts and Sponsors

1. Center for Water Policy
2. Freshwater Collaborative of Wisconsin
3. University of Wisconsin Water Policy Network
    i. UW-Milwaukee
    ii. UW-Madison
    iii. UW-Stout
    iv. UW-Stevens Point Extension Lakes
4. Wisconsin Department of Natural Resources
5. Wisconsin Department of Agriculture, Trade and Consumer Protection
6. Alliance for the Great Lakes
7. The Palmer Foundation
8. Environmental Law Section of the Wisconsin State Bar

F. Agenda, Panels and Posters

1. Agenda: view full agenda.

2. Panels:
    i. View speakers list and bios.
    ii. View panel descriptions.
3. Posters: view posters list and bios.

G. Panel Session Writeups

Please see below for detailed summaries of each panel session:

1. Foundation: Setting the Stage – WI P Management Framework & Voluntary Compliance Programs
2. Panel: Land Use, P Runoff, and Understanding the Physical System
3. Keynote Address: Dan Egan, *The Devil's Element: Phosphorus and a World Out of Balance*
4. Panel: WI P Policy Implementation
5. Panel: P Management Case Studies
6. Wrap Up: Future Research & Next Steps

Foundation: Setting the Stage – WI P Management Framework & Voluntary Compliance Programs

February 7, 2023 | 9:45 am – 10:45 am

Speakers:

Matt Claucherty, Phosphorus Implementation Coordinator with the Water Quality Bureau at the Wisconsin Department of Natural Resources ("WDNR")

Cody Calkins, Conservation Specialist at the Wisconsin Department of Agriculture, Trade and Consumer Protection ("DATCP")

Steve Jann, Water Permits Branch Manager at U.S. Environmental Protection Agency ("EPA") Region 5

Moderated by **Sara Walling**, Senior Policy Manager with Alliance for the Great Lakes

Video Recording: view full foundation session recording.

Topic 1. Matt Claucherty, WDNR: Overview of WI P rules, regulatory compliance, DNR's role in policy implementation

Nutrient pollution is one of the most widespread, costly, and challenging environmental issues in the United States. Wisconsin has been at the forefront of regulating the limiting nutrient phosphorus for over a decade. Wisconsin promulgated narrative standards and technology-based limits, but these regulations did not effectively manage the problem. After public outcry and threatened legal action in the 2000s, Wisconsin adopted numeric phosphorus criteria for surface waterbodies in 2010. With these new criteria, it was clearer to see water quality impairments, which led to a surge in 303(d) listings of impaired waters. Once a waterbody is identified as impaired, the WDNR creates a clean-up plan, or total maximum daily loads ("TMDL"), as the next phase of regulation for point sources versus nonpoint sources.

- Wisconsin has rich agricultural production, so phosphorus is essential, but it must be managed in Wisconsin's waterways.
    - Phosphorus is the limiting nutrient in most cases for algal growth in waterways.
- There are many sources of phosphorus pollution:

  - Point sources are well-defined and –regulated under permits and include wastewater treatment plants and factories.
  - Nonpoint sources are not as well defined, and include runoff from suburban developments, city streets, rural homes, cropland, and animal feedlots.
- Early steps in Wisconsin to address phosphorus pollution included:
  - Narrative standards at ss. NR 102.04(1)(b) and (c)
  - Technology-based limits at ss. NR 217.04(1)(a)1 and 2
- Eventually, WDNR adopted numeric standards in 2010.
  - NR 102 established numeric standards based on watertypes.
  - NR 217 set effluent standards and phosphorus limitations on discharges to surface waters, applicable to point source dischargers.
  - NR 151 created phosphorus index performance standards for runoff management, applicable to nonpoint source, crop and livestock producers.
- The United States Geological Survey ("USGS") released papers in 2006 and 2008 using break point analysis to define what are appropriate levels of phosphorus in Wisconsin's waters, providing a scientific basis for Wisconsin's numeric standards.
- The state released an economic impact analysis in 2015, which found that a heavy-handed approach to requiring phosphorus regulation would result in steep economic costs including job loss. Regulatory flexibility is required.
  - Agricultural phosphorus is the low-hanging fruit; phosphorus management is much more economical on the agricultural side.
  - Eighty-two percent of phosphorus loading to surface waters in Wisconsin comes from nonpoint sources.
- TMDL development is the next phase of regulation.
- The influx of funds from the Bipartisan Infrastructure Law ("BIL") into State Revolving Funds ("SRF") is a huge opportunity to empower communities.
- Technology could stem acute issues and keep phosphorus out of water to begin with.

Topic 2. Cody Calkins, DATCP: DATCP's role in P management, WI P Index, voluntary incentive programs, local nutrient management plans

Situated within the Bureau of Land and Water Resources, DATCP partners with government agencies at all levels and landowners to conserve soil, prevent agricultural runoff, and preserve farmland and infrastructure. WDNR is empowered by state statute to set agricultural performance standards for the state. DATCP runs grant programs and voluntary conservation programs to help landowners conserve soil and prevent runoff. The Bureau has found that voluntary programs are the way forward for effective nutrient management.

- At the state and county regulatory level, DATCP provides technical guidance to partners and other agency staff. DATCP believes that voluntary conservation is the way forward for resource protection.
- WDNR is empowered by state statute to set agricultural performance standards for the state, e.g., NR 151.04(2)(a).
- DATCP is non-regulatory except for those voluntarily participating in its programs, which are administered through Administration Code ATCP 50. Programs include its nutrient management program and its soil and water resource management program.
- All landowners who apply nutrients to any field, including pastures, should have a nutrient management plan written by a qualified planner. The plan should be based on soil nutrient tests conducted by a certified lab. The plan must not exceed limits in UW Extension Publication A2809 (2012).
    - The primary method that farmers use to manage nutrients is the SnapPlus nutrient management software.
- The Farmer Preservation Program requires conservation compliance with all conservation provisions. Thirty-three percent of Wisconsin agricultural land is covered under a nutrient management program.
- The Producer-Led Program is also very popular.

Topic 3. Steve Jann, EPA: EPA's role as WI adopted numeric P criteria (multi-discharger variance and WPDES program) and EPA's current national and Region 5-scale efforts to reduce nutrient pollution

The EPA is empowered by the Clean Water Act ("CWA") to regulate water quality standards and administer programs to achieve compliance. Cooperative federalism allows states to run the CWA programs with oversight from the EPA. The EPA Region 5 has found Wisconsin to be the leader in phosphorus regulation and management among the Great Lakes states. Adaptive management was particularly challenging for the EPA to approve, but eventually it did approve it because it was so effective.

- The CWA recognizes that states are primarily responsible for managing water quality within their jurisdictions. It creates a role for the EPA to oversee and partially fund state programs tethered to the Act.
    - The CWA creates programs and funding for projects for nonpoint sources.
    - The CWA empowers the EPA to approve or disapprove actions by the states.
    - The CWA created the Clean Water State Revolving Fund program to provide funds for water infrastructure to municipalities.
    - The CWA also awards grants to partially fund state programs.
- The EPA approved the Wisconsin Pollutant Discharge Elimination System ("WPDES") program in 1974. In 2010, Wisconsin adopted numeric phosphorus criteria and companion WPDES rules. Wisconsin sent both the numeric criteria and companion WPDES rules to the EPA during both the draft and final stages. There was extensive EPA-WDNR dialogue on the drafts.
- Wisconsin's adaptive management program was a challenge for EPA National Pollutant Discharge Elimination System ("NPDES") reviewers because it was the first of its kind.
    - The EPA was wary of approving the adaptive management rule because that would declare that it was in compliance with the CWA and open the EPA up to potential litigation. However, they ultimately decided to approve it.
- Federal funding to the state of Wisconsin: the BIL reflects historic investment in water and wastewater.

- In Fiscal Year 2022, Wisconsin received $48 million of incremental funding.
- Wisconsin received a total of $141 million from Congress for clean and safe water programs in the state.

Panel: Land Use, P Runoff, and Understanding the Physical System

February 7, 2023 | 11:00 am – 12:15 pm

Speakers:

J. Val Klump, former Dean and Professor Emeritus at the School of Freshwater Sciences at UW-Milwaukee

Tihitina Andarge, Professor of Economics in the Dept. of Resource Economics at UMass Amherst

Eric Booth, Research Scientist in the Depts. of Agronomy and Civil & Environmental Engineering at UW-Madison

Randy Jackson, Professor of Grassland Ecology in the Dept. of Agronomy at UW-Madison & Principal Investigator of Grassland 2.0

Moderated by **Katy Schultz**, Owner, Tri-Fecta Farms, and former President of the Professional Dairy Producers of Wisconsin

Video Recording: view full panel session recording.

Topic 1. J. Val Klump, School of Freshwater Sciences, UW-Milwaukee:
Eutrophication in the Great Lakes, impact of climate change on P management

Effective management of phosphorus loads in Green Bay will require sustainable practices and reduction in nonpoint source pollution from agricultural sources. Effective plans require robust data collection and an eye on the impact of climate change on Bay conditions and increasing phosphorus levels in the water.

- Green Bay, Wisconsin, receives one-third of the total phosphorus load to Lake Michigan. The Bay has been hyper-eutrophic for decades. Consequences include the loss of habitat, food web alterations, and a "dead zone" within which the oxygen concentration sometimes falls to zero percent, resulting in fish kills.
- The TMDL for Green Bay calls for a 40% reduction in phosphorus loading. The major source of phosphorus reduction to target is agriculture.

- Any effective management plan needs to focus on areas with phosphorus hot spots. An effective management plan, using conservation tilling practices, can result in significant reduction in phosphorus loading to Green Bay, which Dr. Klump believes will result in rapid improvement in the conditions causing the "dead zone."
- Research on climate change shows that "business-as-usual" phosphorus management practices, without any changes accounting for intensifying weather events, will result in increased phosphorus loading and hypoxia elevation in the Bay.
    - Hypoxia has become more of a problem over the last couple of decades.
    - Climate change can result in lengthening of the stratified period in the bay with larger hypoxic zones and more hypoxic conditions in the water.
- A forty to fifty percent reduction in phosphorus is needed to meet water quality targets, back to 1970s levels.

Read more here: Evidence of Persistent, Recurring Summertime Hypoxia in Green Bay, Lake Michigan; The Green Bay Saga: Environmental Change, Scientific Investigation, and Watershed Management.

Topic 2. Tihitina Andarge, Dept. of Resource Economics, UMass Amherst:
Efficacy of local manure management ordinances on WI dairy farms, impact of local regulations on water quality outcomes

The study of near-term impacts from county-level manure management shows that nutrient management plans are generally effective for reducing phosphorus concentrations and improving water quality. Examining the impact of local manure regulations on farmer behavior and linking that to water quality has been identified as a priority area for future research.

- Dairy is central to Wisconsin's economy and represents just under half of the total agricultural value. However, there is growing evidence that dairy farming is impacting water quality in Wisconsin.
    - Literature shows that most of the impairment to the water comes from nonpoint sources, since point sources are mitigated by the CWA.
    - Water quality is better in watersheds with some county-level manure management. Nutrient management plans are effective.

- Regulations come at a financially challenging time for Wisconsin farms. The number of farms going bankrupt is on the rise, which shows the importance of scientific data to highlight the most effective regulation measure to lower pollution levels.
- The variation in enforcement of manure production comes from county-level enforcement power. Manure ordinances are critical to effective management of nonpoint sources.
- Ordinance data and data on water quality, in combination with other data sets, were used to empirically study the impact of ordinance regulations on water quality.
    - Nutrient management plans in ordinances are shown to lower ammonia concentrations.
    - Silurian bedrock rules are shown to reduce both ammonia and phosphorus levels.

Read more here: Effectiveness of Local Regulations on NonPoint Source Pollution: Evidence from Wisconsin Dairy Farms.

Topic 3. Eric Booth, Depts. of Agronomy and Civil & Environmental Engineering, UW-Madison: Recent trends in major drivers of P transport and county-level agricultural P budgets across WI, impacts of management changes on water quality

Progress has been made on several fronts in phosphorus management in Wisconsin. There are new management and compliance tools focused on nonpoint sources. There is more adoption of urban and agricultural best management practices ("BMPs"). There is more farmer-to-farmer knowledge sharing like in watershed councils. There is less phosphorus fertilizer use, less mineral phosphorus feed, and less phosphorus in municipal wastewater effluent. However, the scale of progress does not match the scale of the problem. Substantial phosphorus reductions are still needed to meet water quality goals.

Here are some of the driving factors of phosphorus loss to surface water:

- There are more frequent and more heavy rainfall events leading to increased phosphorus runoff.
- More soil disturbance and less ground cover leads to more phosphorus loss.

    - There is less pasture, more corn and soy farming, and less hay/haylage.
    - Expanding corn and soy leads to more erosive conditions.
- Increased adoption of conservation tillage and no-till leads to less phosphorus loss. However, the effect so far is moderate.
    - There is an increase in adoption of cover crops, though the adoption rate is still minimal in Wisconsin.
- Data on phosphorus mass balance indicate most counties show phosphorus depletion, leading to less phosphorus runoff. However, dairy-intensive counties continue to accumulate phosphorus and are therefore more prone to phosphorus runoff.
- Progress has not been quick enough to overcome factors working in the other direction.
- To reach water quality goals, we need to substantially scale up low-disturbance perennial cover with lower and more balanced nutrition applications. We need to continue experimenting and innovating, leaning into perennial systems.

Read more here: Data Inaccessibility at Sub-County Scale Limits Implementation of Manuresheds; Phosphorus Flows and Balances for the Lake Mendota and Yahara River Watersheds: 1992-2017.

Topic 4. Randy Jackson, Dept. of Agronomy, UW-Madison and Grassland 2.0: Transformative land use change to perennial grasslands

Transformative land cover change is required to meet our water quality goals in Wisconsin. Phosphorus loading is getting worse. Water quality is not improving. If we only focus on phosphorus runoff and not all the other impacts on water quality and sustainable practices, we will not meet our water quality goals.

- Transformative land cover and land use change is required to restore the function of the prairie.
- Ecosystem functions that are critical to our health and well-being are provided by agriculture that incorporates all of the following:
    - Undisturbed soil
    - Dense continuous canopy
    - Few inputs into the system
    - Deep fibrous roots

    - Diverse communities
    - Net energy gain that builds carbon more than it loses carbon
    - Thoughtful, adaptive management
    - Land Ethic: we can only have as many animals on the land as the land can support. Fewer animals are necessary.
- Multi-functional agriculture is possible and is being demonstrated all over the upper Midwest and beyond. Wisconsin needs to establish well-managed grazed grassland to support the ecosystem and protect the water.
- Real world data shows that grazing systems are more profitable than the confinement feed system.
- Grassland agriculture reduces the ability of corporations to extract and amass enormous wealth. Poor practices are promulgated and reified by extractive corporations.
- Transitioning from extractive to genuinely regenerative agriculture will be costly and painful but likely less costly than infrastructure, health, and well-being 'repair' under the current system because it'll be transition costs rather than recurring expenses. We have to incur infrastructure transitions costs, reduce perverse land valuation, and build on 125 years of "progress."
- We don't need more data; we need more action on political and institutional levels.

Read more here: Perennial Grassland Agriculture Restores Critical Ecosystem Functions in the U.S. Upper Midwest; Agricultural Landscape Transformation Needed to Meet Water Quality Goals in the Yahara River Watershed of Southern Wisconsin.

Keynote Address

February 7, 2023 | 12:30 pm – 1:30 pm

Speakers:

Dan Egan, Brico Fund Journalist in Residence at the Center for Water Policy, School of Freshwater Sciences at UW-Milwaukee

Melissa Scanlan, Lynde B. Uihlein Endowed Chair in Water Policy, Professor, and Director of the Center for Water Policy, School of Freshwater Sciences at UW-Milwaukee

Introduced by **Rebecca Klaper**, Dean and Professor, School of Freshwater Sciences at UW-Milwaukee

Video Recording: view full keynote session recording.

Topic: Keynote conversation with Dan Egan and Melissa Scanlan about Egan's book, The Devil's Element: Phosphorus and a World Out of Balance

Phosphorus has a dual nature as both something we need to survive and thrive and something we are suffering from because we have too much of it in many places. Something must change from our current unsustainable path. Beyond the low-hanging fruit which has been addressed, it is a tough, complex problem. Manure is going to have to be a huge part of the solution going forward. We also need to figure out how to use phosphorus repeatedly going forward in more closed/recycling systems. Though regulations in this country and elsewhere have led to operational and technological improvements, we have a long way to go on public awareness of these issues and addressing the more recent surge of phosphorus running off agricultural land after liquid manure from livestock factories is applied to cropland.

- We may face phosphorus scarcity in the near future, but right now there's too much of it in too many waterbodies. The United States' supplies of mined phosphorus, which is used in chemical fertilizers, may only last another 30-50 years. We need phosphorus and we need to stop using too much of it.
- We cannot sustain the current path. Ethanol, which represents 40% of the corn crop, is a good place to start.

- We can regulate phosphorus inputs and the runoff performance of agriculture, cities, and point sources. Manure management is a huge part of what we need to do going forward, for Lake Erie and many other places.
- We need to figure out how to recycle phosphorus repeatedly to create less leaky systems. Concentrating phosphorus out of waste streams and using it again as fertilizer is a part of that.
- The vicious cycle of excess nutrients, i.e., phosphorus, broken ecosystems, invasive species, and climate change represent a real human health crisis in a variety of places, from Lake Erie to Lake Okeechobee, Florida.
- A 2018 agreement between the Unites States and Canada promised a 40% reduction of phosphorus by 2025 in Lake Erie but did not include any mechanisms to meet the goal. We are not moving fast enough to meet that goal, and we're paying the price elsewhere with toxic blue-green algal blooms.
- Strict phosphorus standards in the sewage treatment waste stream in Hamburg, Germany led to an innovative pilot sewage treatment plant that gets essentially 100% of phosphorus out of the wastewater to be reused as fertilizer.

Panel: WI P Policy Implementation

February 7, 2023 | 1:40 pm – 2:40 pm

Speakers:

Ken Genskow, UW-Extension Specialist & Professor of Environmental Planning & Policy at UW-Madison

Zach Raff, Associate Professor of Economics in the Social Science Dept. at UW-Stout

Adena Rissman, Professor of the Human Dimensions of Ecosystem Management in the Dept. of Forest & Wildlife Ecology at UW-Madison

Moderated by **Cheryl Nenn**, Milwaukee Riverkeeper

Video Recording: view full panel session recording.

Topic 1. Ken Genskow, Environmental Planning & Policy, UW-Madison:
WI innovative P compliance options for regulated entities, policy implications

There are several market-like options available for point sources to meet the limits set by the phosphorus rules. These market-like programs have taken time to mature as they require a major shift in practice.

- Market-like options include:
    - Water quality trading focuses on managing phosphorus loads within a watershed to meet WPDES permit limits. Point or nonpoint sources can earn "pollutant reduction credits" by reducing their phosphorus loads. Point sources may then come into compliance with permit discharge limits by purchasing these credits in lieu of making costly facility upgrades. The requirement here is an overall phosphorus reduction in the shared watershed.
    - Adaptive management focuses on reducing phosphorus concentration in a given watershed with the goal to meet the numeric phosphorus criteria for that waterbody. Point sources wishing to use this voluntary compliance option would fund phosphorus management projects for other point or nonpoint sources in the shared watershed.

    - Multi-discharger variance is available to point source producers and allows them to extend their timeline for compliance with phosphorus effluent limits in exchange for paying into a fund for phosphorus reduction projects.
- A study was performed on factors influencing participation in Wisconsin's market-like options using literature reviews, interviews, data review, modeling, and other sources. The study found:
    - Facilities in relatively poor condition were more likely to choose an upgrade option.
    - Smaller/rural communities were more likely to select multi-discharger variance.
    - The more years it had been since they were notified of the plan, the more likely they were to select adaptive management or water quality trading options.

Read more here: Trading, Adaptive Management, MDV, or Upgrades? Decision Drivers in Wisconsin's Phosphorus Credit Markets.

Topic 2. Zach Raff, Social Science Dept., UW-Stout: WI P rules innovative compliance options, economic impact to consumers

WDNR's offset trading program represents an opportunity to lessen the welfare impacts of stringent discharge limits. It is important to minimize the transaction costs of water pollution offset trading to stimulate more trade. Market solutions can both lower phosphorus pollution and reduce the cost of point sources becoming compliant with Wisconsin's phosphorus rule. Offset trading is an effective and efficient method to help point sources reduce phosphorus pollution.

- Wisconsin's phosphorus rules created the most stringent water quality standards for phosphorus in the country. This creates a lot of compliance costs.
- When producers face additional costs of environmental regulation, economists and policymakers share interest in examining how these increased input costs affect end users and welfare.
- Rather than engage in expensive abatement technology upgrades, point sources can comply with water pollution regulations through the water quality market

where they trade discharge offsets with others, usually nonpoint sources, at cheaper costs.

- Research questions:
    - How does the rule affect sewer utility prices?
    - How much of the compliance cost is passed through to the end user?
- Nonpoint sources of water pollution are the largest contributors to surface water impairment in the United States. Controlling these sources presents a cost-effective way to reduce water pollution. However, controlling nonpoint sources is politically challenging. One way to do so is through water pollution offset trading.
- This study used data with NPDES permit information, phosphorus rule compliance information, sewer utility billing rates, and balanced, yearly panels of surveyed sewer utilities.
    - The study looked at differences in utility rates before and after compliance with phosphorus standards. The study considered the differences in utility rate increases between the different compliance options.
    - The study found that municipal sewer utilities that complied with the rule via offset trading increased their rates by 6.4%, in comparison to an increase of 14.6% for sewer utilities that comply with the rule using treatment technology upgrades.

Read more here: [The Effect of Water Pollution Regulation on Prices: Evidence from Wisconsin's Phosphorus Rule and Sewer Utility Bills].

Topic 3. Adena Rissman, Dept. of Forest & Wildlife Ecology, UW-Madison: Where, when, and how WI P policies address agricultural nutrient management

Developing a better institutional fit in addressing our farming and water quality needs can result in better implementation of water quality standards and help producers reduce phosphorus pollution.

- We have had the same goals for reducing phosphorus in the water for decades, but we are still not meeting our overall goals for phosphorus reduction.
- Institutions establish the rules, policy goals, and management systems that help us measure, achieve, and balance our goals.

    - We have goals which include abundant food and fiber, clean water for drinking, swimming, and fishing, profitable farms, and good health.
    - How do we balance these goals and meet as many of them as we can?
- We spend $1.5 - 5.4 billion per year on federal subsidies and crop insurance.
    - Most of this is targeted at corn and soy at the cost of grassland.
    - We need to invest more in farmers on the ground so they can economically transition into widescale land cover solutions.
    - We should be combining federal dollars with state and local dollars to implement these solutions.
- We can improve reductions in phosphorus by fully funding counties, increasing nonpoint reduction incentives, implementing pay for performance, and gradually matching standards with needs.
- We need to think bigger; we need a bigger land cover solution.

Read more here: Progress on Nonpoint Pollution: Barriers & Opportunities; Uncertain Monitoring and Modeling in a Watershed Nonpoint Pollution Program.

Panel: P Management Case Studies

February 7, 2023 | 2:45 pm – 4:00 pm

Speakers:

Darrell Smith, Watershed Program Manager for the Oconomowoc Watershed Protection Program

John Koepke, Owner & Farmer, Koepke Farms, Inc.

Chris Murphy, Conservation Specialist for Rock County Land Conservation Dept.

David Botts, Utility Director with the Public Works Dept. for the City of Janesville

Moderated by **Margaret Krome,** Policy Program Director with Michael Fields Agricultural Institute

Video Recording: view full panel session recording.

Topic 1. Darrel Smith, City of Oconomowoc and John Koepke, Koepke Farms, Inc.: Adaptive Management Case Study

Wisconsin's alternative phosphorus reduction policy tools can help widen the geography and group of people benefitting from investments in watershed phosphorus reduction, as in the City of Oconomowoc's Watershed Adaptive Management Option project. Farmers are helping lead the innovation that's happening in Wisconsin. Leopold's Land Ethic is alive and well in Wisconsin. Having farmers show other farmers what's working for them (and the bottom line) really helps.

- The City of Oconomowoc chose the Adaptive Management project because it saves money and improves lake water quality for residents, which would not happen with sewage treatment plant upgrades as the plant is downstream of the lakes.
    - The City of Oconomowoc partnered with Koepke Farms to implement an adaptive management program in the Oconomowoc River Watershed.
    - Phosphorus levels in the river are being driven down by Adaptive Management.
- Some of the adaptive management projects from this program include:
    - Farm field conversion to prairie to control flow of runoff.

    - Stream re-meandering projects.
    - Cover crops with aerial seeding.
- Farmers like John Koepke and his watershed group operate with a conservation land ethic and find value in restoring and protecting our land and waters. There is a lot of investment here and farmers hold each other accountable within their farming communities.
    - Koepke Farms is a dairy farm milking and raising 350 heifers.
    - Soil health is a key focus. They use no tilling and well-thought-out crop rotation to always keep roots in the ground year-round over three-year cycles.
- It's important to document your successes along the way so you can spread them far and wide.
    - Tracking good data is also very important so you can learn what works and what doesn't.
    - Farmers need to share with younger generations the why and the how.

Topic 2. Chris Murphy, Rock County Land Conservation Department and David Botts, Public Works Department, City of Janesville: Water Quality Trading Case Study

The County Land and Water Conservation Department is an invaluable partner for permitted point sources pursuing market-based approaches to address nonpoint runoff in the watershed. They're a resource for the city and the farmers.

- Case study of Janesville water quality trading project:
    - Janesville is paying agricultural producers to reduce their phosphorus runoff because it costs the municipality less than reducing phosphorus from the sewage treatment facility.
    - Janesville determines the amount of phosphorus credits needed to meet their permit requirements, reviews and approves practices they'll be paying for, and sets up agreements with farmers.
    - The County Land and Water Conservation Department is like a facilitator of the transaction. It helps design practices in concert with farmers and inspects and reports back to the city.
- Blueprint for success:
    - Build partnerships to maximize resources.

    - Keep it user friendly.
    - Look for win-wins, like guaranteed economic return plus control of land use in exchange for long-term, cost-effective phosphorus reduction.
    - Design locally led efforts with little government dictation and let the local actors take the lead on project design.
    - Maximize cost efficiency by working with "priority farms" to reduce the largest amounts of phosphorus runoff.
- How do we drive phosphorus runoff down with the array of practices we know work but are a departure from what farmers know?
    - We have to ask farmers what solutions work for them instead of pushing what we think they should do.
    - Once there's a trusting relationship, you can partner to reduce phosphorus runoff.

Wrap Up: Future Research & Next Steps

February 7, 2023 | 4:05 pm – 4:30 pm

Speakers:

Ken Genskow, UW-Extension Specialist & Professor of Environmental Planning & Policy at UW-Madison

Melissa Scanlan, Lynde B. Uihlein Endowed Chair in Water Policy, Professor, and Director of the Center for Water Policy, School of Freshwater Sciences at UW-Milwaukee

Video Recording: view full wrap up session recording.

Topic: Key takeaways from panel sessions, top questions for future research agenda

The conference had two goals:

(1) identify a research agenda for the next decade; and
(2) identify gaps in policy and places where policy needs to evolve.

The Foundation Panel reviewed the basis for where phosphorus rules came from and how they built on previous work in Wisconsin. The first Academic Panel discussed challenges with managing phosphorus across the landscape. The second Academic Panel discussed phosphorus policy and implementation. The Case Study Panel shed light on details of how programs are implemented and why communities get involved in adaptive management. The Keynote provided a national and international analysis of the challenges posed by phosphorus management on land and water.

- Further questions included:
    - What really motivates a land manager or farmer to conserve phosphorus?
    - How do we integrate phosphorus management with nitrogen management and other needs such as carbon sequestration, so we focus on holistic land and water management?
    - How do we integrate TMDL reductions and phosphorus index values into action plans, and get those plans implemented? What are the drivers to move the phosphorus index, which was set based on politics rather than

the needs of crops and concerns about water pollution? How can we make it more implementable?
    - How do we make the multi-discharger variance program more flexible and accessible?
    - How can we use and access the federal dollars coming into the state effectively? How much of the funds can address nonpoint pollution? Can those dollars be grants or forgivable loans?

- Highlights from audience input include:
    - How much is legacy phosphorus a component of current phosphorus loads?
    - What's an appropriate, sustainable funding source to pay for conservation practice implementation?
    - How do we support placemaking processes in watershed groups that are focused on multifunctional outcomes?
    - How do we improve cover crop adoption rates in Wisconsin?
    - How can we scale up the success of water quality trading and adaptive management practices to reduce more nonpoint source pollution?

H. Academic Research Agenda

Conference presenters and participants worked together to identify phosphorus research gaps and questions for University of Wisconsin System researchers to study and answer in the next decade. Three phosphorus research areas to prioritize are: (1) agricultural phosphorus management; (2) monitoring, evaluating, and scaling policies/programs; and (3) phosphorus in the environment and water quality. Questions for each area are listed below grouped by theme. Some questions address more than one priority area.

1. **Agricultural phosphorus management**
    - *Transformative agricultural system change*: If the goal is to recalibrate land management with water quality across watersheds…
        - What proportion and configuration of agricultural land within a watershed should be in well-managed, grazed perennial grasslands to meet established water quality goals?
        - Can cropping systems be configured and managed to meet phosphorus and other societal goals simultaneously (i.e., profitable farming; nitrogen, soil, and carbon retention; biodiversity and habitat; flood reduction; thriving and vital communities)?
    - *Water quality goals*: Given that agricultural phosphorus management goals (specifically Wisconsin Phosphorus Index target value of 6) are not aligned with river and lake water quality goals (see TMDL agricultural targets)…
        - What forms of new incentives or regulations can improve alignment between phosphorus management guidelines and TMDL targets for excess phosphorus leaving agricultural fields?
        - Are watershed-based agricultural TMDL targets implemented effectively?
        - What should the Wisconsin Phosphorus Index target value be to meet water quality criteria? (See Section 3, Phosphorus in the environment and water quality, subsection: "Measuring phosphorus reduction and the impact on water quality," for a question about using LiDAR to more accurately assess

agricultural phosphorus runoff and recalculating Wisconsin Phosphorus Index values).
    - What is a reasonable timeframe over which this regulatory change should occur?
    - When can we reasonably expect waterbodies to meet numeric phosphorus criteria if the Wisconsin Phosphorus Index target values are set at levels designed to meet water quality criteria?
- *Farmer behavior and land management practices*: Recognizing the cumulative environmental impacts of many individual decisions by farmers, further exacerbated by climate change…
    - What influences farmers to change practices, such as implementing land conservation or converting to grasslands, to reduce phosphorus runoff?
    - What are the best ways to incentivize more farmers to adopt best management practices, nutrient management plans, and other crop management systems?
    - What farm-specific variables (size, business type, products, etc.) most heavily influence participation in incentive-based programs?
    - What are the most effective elements of farmer-to-farmer initiatives to maximize reductions in agricultural phosphorus inputs to Wisconsin waterbodies?
    - What do the most successful producer-led watershed groups have in common in terms of reducing phosphorus concentrations in local waterways?
    - What are the most effective methods for maximizing farmer participation in producer-led watershed groups?
    - How can networks of conservation professionals best support producer-led watershed groups?
    - What technologies or techniques can farms employ to draw down soil test phosphorus levels at an expedited rate?
    - How do corn subsidies for biofuel production impact farmers' behavior and land management practices?

    - What parts of the Farm Bill could be amended to remove subsidies for farm practices that increase phosphorus runoff?
- *Concentrated Animal Feeding Operations (CAFOs)*: Specifically regarding CAFOs…
    - To what extent do outfalls from tile drains on fields where CAFOs are spreading liquid manure contribute to total phosphorus loads?
    - How can technologies or techniques for farms that draw down soil test phosphorus levels at an expedited rate be integrated into the acreage utilized by CAFOs for manure spreading?
- *Quantifying costs and benefits*: Focusing more closely on market-like and value-added opportunities…
    - What are the costs and benefits of an emission trading system where farmers generate and sell emission reduction credits by capturing methane gas with biodigesters?
    - Could grassland farmers sell carbon credits for sequestering carbon and make this type of farming even more attractive?
    - What are the true costs and benefits of the current agricultural system and is it a net positive or negative for society in terms of environmental and human health?
    - How can we account for externalized costs of the current agricultural production system, such as soil degradation, greenhouse gas emissions, and water impairment?
    - What are the projected trends in agricultural production (especially for CAFOs and dairy farming) over the next 20 years and what would it take to offset the economics of large-scale operations in favor of smaller, lower entry fee, and more ecologically sustainable operations?
    - How can farms more effectively pass pollution control costs onto consumers while remaining competitive?
    - How will the depletion of U.S. mineral phosphorus sources impact the costs and management of phosphorus for agricultural production?
    - What is the economic impact of sustainable, watershed-scale

management focusing on ecological restoration and water quality?

2. **Monitoring, evaluating, and scaling policies/programs**
    - *County-level phosphorus management*: Recognizing the multiple roles carried out by Wisconsin counties…
        - What are the advantages and disadvantages of placing conservation authority in county land and water offices?
        - What are the long-term effects of local county manure ordinances on total phosphorus concentration and water quality?
        - What percentage of NR 151 violations are resolved through county offices? For those unresolved, what factors contributed to the outcome?
    - *Tracking and reporting progress*: With high variability in approaches and wide data gaps…
        - What are the best key performance indicators to use for tracking and reporting progress?
        - What is the relationship between phosphorus criteria and listing or removing waters from the 303(d) list of impaired waters? This should be monitored over time.
        - Do conservation practices funded by cost-share programs generate measurable, long-term crop and nutrient management changes?
        - How do nutrient management plans and market-like compliance options (adaptive management and water quality trading) contribute to measurable, long-term impacts on water quality improvement?
        - How can satellite-based remote sensing data be better leveraged to monitor agricultural management changes and implementation of conservation practices? How can these datasets be developed and widely shared while respecting data privacy concerns?
    - *Scaling successes*: In order to reach statewide and regional impacts…
        - How can smaller, successful water quality trading and adaptive management programs be scaled up to reduce larger, nonpoint

sources of phosphorus?
    - Given that water quality trading and adaptive management exist due to demanding phosphorus regulations for point sources, what mechanisms could mandate that agricultural producers participate in the market-based approach?
    - Will the new Clearinghouse for nutrient trading in Wisconsin result in more point to nonpoint trades with measurable decreases in phosphorus levels in surface waters?
- *Challenges and opportunities associated with nutrient regulations:*
    - In what ways have regulations failed to protect water quality, and what can we learn from these shortcomings?
    - What forms of novel land/nutrient management regulation would see less opposition in the political and agribusiness spheres?
    - What are operational challenges and opportunities for CAFO-permitted fields to achieve TMDL-based agricultural phosphorus targets?

3. **Phosphorus in the environment and water quality**
    - *Legacy phosphorus in sediment and soil*: Addressing the substantial accumulation of soil phosphorus over time…
        - How long will it take to reduce legacy phosphorus in soils?
        - How do we account for the release of legacy (stored) phosphorus and the lag time effect of phosphorus management strategies for reducing phosphorus loading in rivers versus lakes?
        - What are effective technologies and solutions to reduce legacy phosphorus release from sediments, soils, floodplains, streambeds, and waterbodies?
    - *Forms of phosphorus*: How do different forms of phosphorus (e.g., organic, inorganic, particulate) interact with regional geology and aquatic ecosystems to contribute to phosphorus pollution and impact water quality?
    - *Nuisance or Harmful Algal Blooms (HABs)*: Recognizing the negative public and environmental health impacts of HABs…
        - Are HABs happening more often and in more places?

    - What clues do nearshore hydrodynamics provide in understanding why cyanobacteria blooms (HABs) tend to happen where they do?
    - How does the intake and excretion of phosphorus by invasive dreissenid (zebra and quagga) mussels affect HABs in the Great Lakes versus inland lakes and nearshore versus offshore? How does the presence of dreissenid mussels affect phosphorus management strategies?
- *Measuring phosphorus reduction and the impact on water quality*:
    - How well do field and watershed scale models reflect measured phosphorus and sediment losses?
    - What existing data and technology gaps must be overcome for development of a nearshore phosphorus model, which is required to set phosphorus effluent limits for point sources to protect Great Lakes nearshore waters? (See Wis. Adm. Code § NR 217.13(4)).
    - Considering the effects dreissenid mussels have had on in-lake phosphorus cycling, is there an optimal phosphorus load for Lake Michigan (or other Great Lakes) that will support a productive offshore fish community while minimizing the problem of nuisance algae in the nearshore zone?
    - What are the limitations of periodic (e.g., monthly) sampling of phosphorus in streams that commonly miss the storm events that transport the vast majority of phosphorus? Should phosphorus reduction monitoring focus primarily on low-flow phosphorus concentration or accurate (but more costly) annual phosphorus load?
    - How can scientists gain a more thorough understanding of the relationships between types/quantities of nutrients applied, soil chemistry, physical field parameters, and physical drainage parameters to build a mechanistic model that can simulate and predict nutrient loading to water via tiles? Can this type of mechanistic model be built into Wisconsin's SnapPlus software without diminishing its value as a nutrient management planning tool for farm operations?

    - Can technologically advanced tools such as LiDAR be used to more accurately assess the flow path of runoff phosphorus from agricultural fields to surface waterbodies, so that Wisconsin Phosphorus Index values can be truly reflective of actual agricultural phosphorus delivery?
- *Hydrologic restoration*:
    - Has hydrologic alteration (i.e., tiling, ditching, compaction) of Wisconsin watersheds accelerated channel migration and increased phosphorus loading from eroding streambanks? If so, to what degree?
    - How should wetland restoration projects be designed to maximize phosphorus capture and filtration?
- *Climate change*: Acknowledging the increasing frequency and intensity of severe weather events…
    - How should phosphorus management plans be adapted in response to a warmer, wetter climate with more frequent and intense rain events?
    - How should phosphorus reduction strategies be adjusted to mitigate climate change (i.e., by promoting grasslands to sequester carbon while reducing runoff of phosphorus)?
    - As the climate warms, what is the absorptive capacity or tipping point for waterbodies not currently heavily affected by agricultural phosphorus pollution?
    - How will a longer growing season (up to 6 weeks longer) affect agriculture in terms of crop selection, double cropping, etc., in the next 20 years?

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I. Policy Recommendations

This section contains policy recommendations for reducing phosphorus pollution and improving water quality in Wisconsin. The goals of these policy recommendations are to promote profitable farming, clean water, healthy soils, stable climate, biodiversity, and vital communities. Achieving these goals will require a long-term commitment to correct nutrient imbalances at field, farm, and watershed levels caused by excess fertilizer and manure applications and animal densities in confinement systems coupled with inherently leaky cropping systems. One especially promising policy direction is promoting grasslands and agroforestry-based food production systems that provide quantifiable pollutant load reductions and correct nutrient imbalances. Short-term and long-term policy recommendations are outlined below.

1. **Fix regulatory gaps and limitations**
    - Initiate via Wisconsin DNR an administrative rulemaking process to revise Wisconsin Administrative Code section NR 151.04 with new, lower Wisconsin Phosphorus Index target values for croplands, pastures, and winter grazing areas (currently set at 6 lbs/acres/year).
        - The new Phosphorus Index target values should be watershed-specific and match the agricultural phosphorus pounds/acres/year necessary to meet water quality goals.
        - See corresponding Research Agenda for a question asking what the new Wisconsin Phosphorus Index target value(s) should be.
    - Initiate via Wisconsin DNR an administrative rulemaking process to set targeted performance standards to reflect agricultural load allocations in TMDLs pursuant to Wisconsin Administrative Code sections NR 151.005 and NR 151.004. Targeted performance standards should be prioritized where they would have the broadest impact for the most impaired waterbodies.
2. **Support effective phosphorus management strategies**
    - To meet water quality goals, Wisconsin's agricultural system needs to transition away from high input annual cropping systems that leak high levels of phosphorus from fertilizer and liquid manure to more ecologically sustainable systems like well-managed, grazed perennial grasslands.

- Provide agricultural cost sharing to farmers for:
  - (a) Continuous cover programs to convert row cropped fields to continuous vegetative cover including grazing and forage mixes, warm and cool season grasses, agroforestry, native prairie, and harvestable buffers and prairie strips.
  - (b) Grazing transition programs such as dairy heifer grazing initiatives to help agricultural producers identify and transition low-productivity and environmentally sensitive areas to perennial grasslands.
- Reinvest in the Grazing Lands Conservation Initiative at the state level.
- Incentivize and reward farmers for the pounds of nutrients reduced and for agroecosystems that produce milk and meat while protecting surface and ground water quality, holding onto soils and nutrients, and supporting biodiversity.

- Increase funding for cost-sharing programs to ensure more non-CAFO fields operate under a nutrient management plan pursuant to Subchapter II of NR 151.
- Ensure producer-led watershed groups have the support and resources needed to establish short-, mid-, and long-term environmental goals for their watershed programs.
  - Develop goal planning tools and templates for groups to use to facilitate this process.
  - Prioritize funding for groups, goals, projects, or activities that incorporate an outcomes-based application and implementation process where water quality, soil health, and profitability goals are articulated and modeled (where feasible) and outcomes are measured to encourage a 'race to the top' among producers to meet watershed goals.
  - Provide significant staffing to run models, install edge-of-field monitoring, conduct watershed planning, and engage with farmers, agency staff, agricultural industry, and the public.
  - Support funding for regional, dedicated support staff to producer-led watershed groups to assist/facilitate group goal

setting, farmer outreach, and tracking/reporting on progress for conservation practices and local social norms shifts.
    - Encourage producer-led watershed groups to promote the implementation of cover crops in their communities to increase the state's current cover crop adoption rate of 6%.
    - Encourage producer-led watershed groups to promote incorporation of perennials and multi-year forages into crop rotations.
- Ensure county conservation offices have the support and resources necessary for developing effective land and water plans, building stronger trust-based relationships with farmers, and facilitating more phosphorus management and land conservation projects, including through water quality trading and adaptive management.
    - Increase allocations within the Governor's budget to Land Conservation Departments so they are fully funded by the state, thereby empowering local entities to prioritize Wisconsin state goals.
    - Provide more training opportunities where needed for county staff to develop enhanced relationship and conservation communication skills.
- Ensure Wisconsin DNR has the support and resources necessary to continue implementing the water quality trading, adaptive management, and multi-discharger variance compliance options effectively.
- Ensure the incoming agricultural workforce has more training in on-farm evaluation of natural resource concerns and agricultural conservation practices.
    - Strengthen the environmental focus in current agricultural education programs.
    - Establish a post-secondary agriculture technical program with an environmental conservation focus.
    - Provide more training to agricultural educators about grazing and other perennial farming practices (i.e., funding for UW-Extension to build more grazing education into trainings for crop

consultants, county Extension agents, financial lenders, and other agricultural educators).

- Develop a phosphorus management planning process that targets phosphorus loading hot spots, areas with the highest phosphorus yields, in order to be most effective in a warmer, wetter climate with more frequent and intense rain events.

3. **Expand public education and outreach**
    - Coordinate with state and local actors to design a public awareness campaign on the implications of phosphorus pollution, including the public health threat, reduced recreational use of Wisconsin's surface waters, and declining waterfront property values.
    - Educate and engage with the public about successful phosphorus management projects with information on how to get involved.
    - Educate and engage with the public about the kinds of transformative agricultural change necessary to meet water quality, soil health, and farmer-profitability goals simultaneously.

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