Upper Mississippi River Basin Association
Water Quality Executive Committee

Nutrient Reduction Strategy Progress Tracking Workshop

April 9 and 13, 2021

Kirsten Wallace welcomed participants and provided background on UMRBA. While UMRBA has traditionally been focused on Clean Water Act programs, nutrient reduction has also been a topic of interest, including working on focused research and comment letters on federal proposals. More recently, the States have expressed interest in using UMRBA to augment their capacity for nutrient reduction in the watershed.

Wallace added that the workshops were an idea and direction of the States. She extended her appreciation to the States for putting the topics and presentations together and to Lauren Salvato for facilitating and coordinating the workshop series.

Focused Conversations on Progress Tracking

Measuring Nutrient Reduction from NPS Best Management Practice (BMP) Implementation

Chris Wieberg shared that Missouri, like the other 12 Hypoxia Task Force (HTF) states, is committed to the goals of nutrient reduction in the HTF Action Plan. One major difference is that Missouri Nutrient Loss Reduction Strategy (NLRS) is missing a numeric baseline on the nutrients discharged to the Mississippi River Basin for point source and nonpoint source loading. Wieberg hopes this will change over the summer as they are meeting with stakeholders to discuss a numeric baseline for nutrients discharged to the river for point source pollution (PS) and nonpoint source pollution (NPS).

Missouri has years of funded conservation practices that have gone unquantified. Missouri's Parks, Soils, and Water Sales tax generates approximately $40 million annually for cost sharing on conservation practices and soil erosion abatement. Missouri DNR is developing a method to estimate nutrient savings from conservation practices in order to quantify the impacts toward the HTF Action Plan nutrient reduction goals.

One method of measuring reduction is through edge of field (EOF) monitoring of BMPs installed. EOF monitoring can verify important assumptions in watershed models like the effective rates of each practice, which in turn can be used to demonstrate success at the community level. However, it is costly and hard to scale.

The Missouri EOF study consisted of 13 monitoring stations across 6 sites to evaluate tillage and fertilizer timings, effectiveness of grass waterways and cover crops, and effectiveness of cover crops vs. no-till.

Takeaways included the following:

- Fertilizer timing: Majority of annual pollution runoff observed at all sites was result of a few (1 to 3) major storm events
- Poorly timed nutrient application exacerbates nutrient pollution

— If you are not seeking progress in structural BMPs alone, move to stacking structural and management BMPs

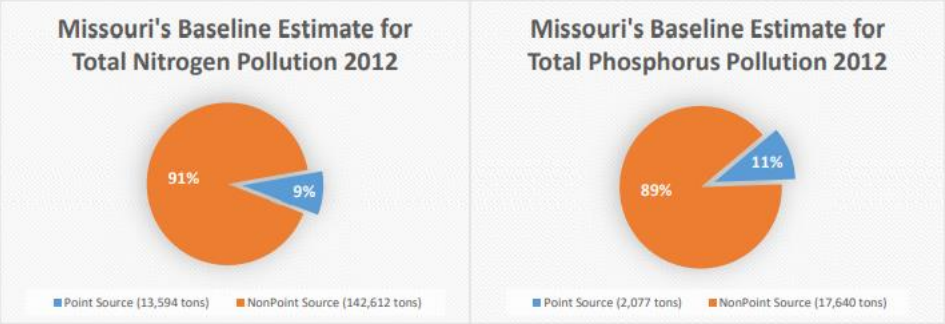
— While the study cannot be replicated across all cost-share BMPs implemented in the state, general findings allow for some basic assumptions to be made in further studies

SPARROW modeling on the other hand is a tool used to estimate loading for the entire state. While cost effective, the model requires more assumptions, results in a less granular approach, and runs the risk of losing sight of local scale successes. Wieberg has been working with staff to determine whether either SPARROW modeling or EOF monitoring can be used, or if both tools can be deployed.

With the HTF grant money, Missouri DNR hired a consultant to evaluate, measure, and quantify the actual reduction from the soil and water conservation program. The original intention was to stand up a water quality (WQ) trading program and figure out cost savings from cost share practices at a HUC 8 level. This has also fed into the baseline discussion. Results are shown below for estimates on total phosphorus (TP), total nitrogen (TN), and combined TN/TP effectiveness.

Practice	Approximate Cost Effectiveness Per Pound TN Only	Approximate Cost Effectiveness Per Pound TP Only	Approximate Cost Effectiveness Combined Per Pound
Ponds	$17	$41	$12
Grass Waterways	$14	$33	$10
Cover Crops	$12	$34	$9
WASCOBs	$8	$20	$6

The contractor also assisted with the baseline discussion and evaluated SPARROW results from past years.



Total Nutrient Baselines for 2012:
Total Nitrogen: 156,206 tons
Total Phosphorus: 19,717 tons

The final step was to come up with a hypothetical methodology for establishing a key performance indicator. The indicator utilizes the SPARROW estimate and state estimates to equal the relative change in annual TN loading from the previous year.

Discussion

Is it harder to defend policy decisions based on 'less-granular' data (i.e., data collected at regional or national scales) and broader assumptions?

Katrina Kessler said Minnesota is constantly challenged with the question. While the state has a comprehensive monitoring strategy at the sub watershed level, it is not enough to evaluate any one particular BMP for its effectiveness. At a high level, Minnesota Pollution Control Agency (PCA) can discuss nutrient trends, but there are not enough data to drive the policy choices and conversations about land practices where there might be the most impact. PCA is working to pilot this on a small sub watershed basis.

Laurie Nowatzke said Iowa is also grappling with the similar questions. Local scale efforts are appreciated but get lost in state level monitoring efforts. Regarding the annual estimates table, Nowatzke asked Wieberg what was meant by key performance indicators and what was measured. Wieberg said the development of the conceptual model is still in progress. He was thinking about it in terms of a potential indicator, the ability of a practice to outcompete other practices. NRCS partners have given Missouri DNR great data to develop that as another key performance indicator for those specific indicators. There is a balance of wanting to give soil and water conservation programs credit, while also showing progress on state wide reductions. Nowatzke replied that she likes the idea of displaying small, mid, and large-scale progress. Iowa is fortunate to have developed modeling approaches, that are working well, with some challenges on assumptions. Iowa has shifted towards state wide load but for each practice, estimating the per acre load reductions e.g., nitrate removal wetland is more efficient than annual reduction in fertilizer application.

Adam Schnieders commented that defending policy decisions based on any kind of data are always a challenge. Schnieders acknowledged that the public does not appreciate the time and scale of what is trying to be accomplished. One of Iowa's goals many years ago was to put in 4,000 wetlands across the state. If you put one in per day, it would take 11 years. Not only that, but engineering, siding, design, and landowner agreements are many facets of what goes into implementation. The five basin states are massively huge land areas, with different level of details. The context of time and scale and magnitude of what is trying to be accomplished gets lost. Wieberg asked how the state developed the number of wetlands needed, and Schnieders replied that Dr. Matt Helmers was involved in the calculation to help the state meet its nutrient loading goals. The team at Iowa State University (ISU) looked at the science assessment, and calculated the amount needed to remove that much nitrogen (N) and phosphorus (P) loading with combination scenarios, as well as costs and scales to achieve the goals.

Margaret Wagner added detail to work happening in Minnesota at different scales. There is EOF monitoring through Discovery Farms, utilized to capture state wide information. In some cases, there is up to seven years of monitoring on an individual farm with nutrient management information aligning with the water quality results. Minnesota also has monitoring at a sub watershed (HUC 8) scale both at EOF and in stream. The monitoring is very expensive and time intensive, and results may not show reductions for a decade. The important thing in Minnesota is good communication between the monitoring programs. The big focus now is realizing the benefit of EOF and bring in help to calibrate the models.

If the state agency has chosen to use a less-granular or less-precise method purposefully over a more-precise method, what examples are there of this use? And why? [Note: this question is a continuation of question one above].

Dave Wall mentioned that Minnesota has both granular and broad approaches. The more granular just two weeks ago was able to adjust some assumptions in one of the models to estimate effects of nutrients

Hydrologic Simulation Program FORTRAN (HSPF) scenario application manager (SAM). This enabled staff to look at a HUC 12 levels and estimate up to the HUC 8 level in the effects of the BMPs. Wieberg said he appreciates hearing Minnesota and Iowa's suggestions and will take it back to his team.

Eric Hettler said Wisconsin has been working on TMDLs with the Soil Water and Assessment Tool (SWAT) model. The SnapPlus model is used for every field in TMDL watersheds. The idea is to get a better sense of EOF loading. Colleagues use outputs of the model to get an idea of the practices to achieve the reduction targets for TMDLs. This is an example of applying a very precise method over a really large area with the ultimate goal of providing guidance to stakeholders. If cover crops are used to improve tillage, nutrient reduction goals for a TMDL may be able to be met. SnapPlus is a Wisconsin specific model developed by University of Wisconsin (UW) Extension and can be found linked here: https://snapplus.wisc.edu/. Other modeling tools that incorporate SnapPlus are https://wpindex.soils.wisc.edu/. Andrew Craig added that SnapPlus has been used within a paired watershed study to reduce NPS pollution from croplands: https://wpindex.soils.wisc.edu/wp-content/uploads/sites/206/2020/12/Carvin-et-al.-JSWC-2018.pdf.

Craig said he works in the NPS program and wanted to follow up on two points that fit into what Hettler described. With SnapPlus, detailed EOF modeling is used and has shown good correlation in terms of EOF reduction to what the model predicted. This could help Missouri take the next step. The other point Craig made was that Minnesota and other states are using satellite imagery to gage what is going on in the landscape, in a HUC 12 or HUC 8 watershed. This is another tool that should be considered and incorporated.

Is there one national or regional scale nutrient modelling approach that stands above the rest?

Kessler said Minnesota partners with NRCS and USEPA, and Dave Wall mentioned the HSPF models for total suspended solids (TSS), eutrophication, and other WQ standards within the states. It is a constant challenge to try to make sure all these aspects agree with one another. Partners are accustomed to models at the local level, and at least for Minnesota, it is working quite well. The hard part is having local models talk to and agree with regional and national models. Matt Drewitz added that Minnesota Board of Water and Soil Resources (BWSR) has been doing work with watershed management plans at the HUC 8 level. A number of models have been used include Prioritize, Target, and Measure (PTM) map, SWAT, and the Agricultural Conservation Planning Framework tool. In some places there are two to four models being used, and it is challenging to figure out how they integrate together, since the models run at different scales. Drewitz said in collaboration with University of Minnesota researchers, an initial comparison of the models was conducted, and the effort can be found linked here: https://www.sciencedirect.com/science/article/abs/pii/S0022169420300330?via%3Dihub. In response to a question from Wieberg, Drewitz replied that conservations do come up when multiple models have different outcomes, especially for sediment and phosphorous. It becomes a communication challenge.

Katie Flahive said she appreciates the conversation. From where she sits at USEPA Office of Water, the agency supports states with planning tools and tracking tools. The tools are different but in some ways they overlap. From a HTF perspective, the coordinating body stands by not having one specific model. There is SWAT, SPAtially Referenced Regression on Watershed Attributes (SPARROW), and other models at the state level that have been supported for years. Flahive believes the most important thing to do is to ensure the data sources and methods are as publicly day-lighted as possible. That is the approach USEPA has taken in the past.

Has your state experienced barriers to success due to a lack of resources to invest in measuring BMP effectiveness?

Wieberg says Missouri struggles prioritizing staff to do work on the nutrient reduction strategy (NRS). He said the reason for the lack of progress is related to resources challenges. Schnieders said what is good and bad is that there are many groups involved in BMP implementation for a variety of reasons. Nowatzke commented that it feels like there is never enough data, and in Iowa, they are always striving to improve the measurement aspect. Another aspect of measuring success is to avoid double counting a practice and accurately portraying what is happening on the landscape, especially conservation practices that are not cost-shared. Wieberg agreed it is challenging when changes happen quickly e.g., carbon credit generation, which also has a side benefit for WQ.

Wagner said her answer may be a little different, as she believes a barrier in Minnesota has been with the perception of research. Some of the initial work to develop and calibrate models was from research funding for BMP effectiveness. Now the research dollars are no longer available, and the research is funded through implementation dollars. The perception that the answers are already known to the research questions can be a barrier. The other piece is the time scale of investing in EOF, and getting past the point of baseline data to the evaluation of the practice. In Discovery Farms, researchers have employed a paired watershed analysis, setting it up so that after a shorter calibration period, information can be gathered in a small watershed with and without the conservation practice. The result is getting to the comparisons more quickly.

When does 'waiting for the perfect data' result in 'failure to launch'? [Note: the question refers to 'perfect data' in terms of quality and quantity.]

Wieberg pointed out that perhaps Missouri's NLRS is not as detailed without making assumptions. He wants stakeholders to understand that an imperfect system is okay as long as the state can demonstrate progress. Wieberg asked workshop participants if they have any stories to share. Nowatzke replied that Iowa is not sheepish about uncertainty. The challenging part is when adjustments are made based on new data. When you have to backtrack on previous findings, that can be problematic.

As the first topic wrapped up, Salvato asked Wieberg if there were any next steps or directions for UMRBA staff. Wieberg replied that future work should be about communication of the NRS. The states are in agreement, the NRS does not have to be perfect, but how that is communicated to stakeholders is important. UMRBA plays a role in increasing communication opportunities and efforts to create unified voices among the states. If the states' NRS are not consistent, at the very least the states can understand one another.

Capturing Private Investment in BMPs

Dave Wall covered four main topics related to assessing private BMP adoption:

- Government assistance program records
- Data about combined private and public
- Local partnership projects
- Permitting related reports and inspections

Government program spending on BMPs has increased since 2004, in part due to the increase in state cost-share. Wall pointed out that landowner cost share is consistent and federal cost share has increased slightly. Minnesota has a BMP tracking system that accounts for spending across state agencies at the HUC 8 watershed and subwatershed scale. Tracking can be aggregated up to the major river basins. This information is helpful to compare against to. The big question is how much is private BMP adoption affecting the 2025 HTF action plan goals?

Data about combined private and public adoption is often challenging to separate but indicators exist. There are four ways that Minnesota looks at this: cropland nutrient management, reduced tillage, EOF practices, and living cover. For cropland nutrient management, fertilizer sales tell us that N and P fertilizer sales are increasing over time. When looking at nitrogen use efficiency, the trend is increasing. On the other hand, a University of Minnesota (UMN) effort concluded using a nutrient balance approach equation, most counties had more nitrogen going on field than what the crop could take in. Farmer surveys, which began collection in 2010 by the Minnesota Department of Agriculture and National Agricultural Statistical Services, indicate that the number of fields exceeded fertilizer recommendations, despite recommendations. Wall added that there is plenty of room for improvement.

Minnesota uses the U.S. Census of Agriculture (Ag) data to understand tillage rates. The results indicated that conventional tillage has decreased while no-till and reduced conservation tillage have increased. The Operation Tillage Information System (OpTIS) project, a partnership with Conservation Technology Information Center, Regrow, and The Nature Conservancy, in contrast shows that a decrease in conservation tillage occurred between 2013 and 2018. A comparable effort has been led by UMN researcher Dr. David Molla. Molla and his team utilize satellite imagery combined with precipitation, soil, soil cover, and slope GIS layers to map crop residue. UMN and OpTIS results are similar, while the main difference lies in the number of acres with crop residue. Satellite images and LiDAR are also utilized to measure EOF practices such as structural erosion control and strategic vegetation (e.g., storage ponds, terraces, sediment basins, grass waterways). While the condition of the practices is unknown, the estimate helps derive a count that can be compared to other datasets.

Ways to measure living cover include data from the U.S. Census of Ag. and satellite images from UMN and OpTIS. While the amount of cover crops differs among the three, the commonality is that the amount of cover crops planted in the state is short of the interim HTF nutrient reduction goals.

An example of a local partnership project is the Root River field to stream partnership which indicates if practices are being adopted. The project is focused on three watersheds. Progress can be tracked through aerial photos, field walkovers, springtime drive-throughs, and regular visits with six crop retailers. The information allows for the comprehensive tracking of changes on the landscape and enables understanding of water improvement attributed to landscape changes.

Finally, for permitting related reports and inspections, the state can access wastewater, urban stormwater, and some information on feedlot runoff and manure spreading. In the future, the state hopes to utilize more information on fertilizer practices in wellhead protection areas with nitrate problems.

In conclusion, Wall said industry is contributing practices on the landscape but private implementation is not as high as previously estimated.

Discussion

Is your state using any different approaches to capture private investment?

Wieberg said that Missouri does not do a great job at capturing private investment. He asked how Minnesota differentiates what is publicly funded vs. privately funded for high level satellite imagery evaluations. Wall replied that the technology is new and so is the evaluation of the information. A possible method is to look at funding levels in the state over time, and subtract acres in government program from the total acres observed to provide an estimate of private contributions. Wieberg added that Missouri has been trying out an accounting process for tracking private dollars. His team developed a GIS component to understand spatially where the funding is coming from, and in an attempt to not double count practices. Drewitz said Minnesota has federal 319 locations and some information in the database linked here: https://gisdata.mn.gov/dataset/env-state-cons-bmp-locs. The information is not accessible for federal EQUIP dollars. Shannon Carpenter confirmed that Federal FOIA is not releasable to that scale. Trevor Sample said Illinois is similar with NRCS data in which it has site specific program for 319 but not on the federal side. Illinois largely uses its nutrient strategy survey, as it relates to the practices for private investment. The data are extracted to state wide levels to get an overall sense of practice adoption.

Schnieders reflected that with new tools such as satellite imagery there is some trust building required to be able to integrate into NRS reporting and to confirm whether it truly reflects that is happening on the landscape. How did Minnesota and others using OpTIS build their trust? Wall replied that because the tool is still fairly new, the trust building is still ongoing. Wall does not have full confidence in the data's accuracy. How good is good enough? It helps that Minnesota has another system through the UMN to compare and contrast results. Since the two efforts are comparable, that gives Wall some confidence but he would not use the tool at a small scale. Drewitz added that the UMN project has had some field validation work. Because of Minnesota's diverse landscapes, growing season, precipitation patterns, etc., researchers have taken digital pictures and used those to correspond to pixels in remote sensing data. Timing of the pictures is key, however. If there are bad snow conditions in the first week of November, timing does not always align. The frequency of satellite coverage is only improving.

Nowatzke said it is challenging with tillage that the OpTIS categories and metrics do not line up with NRCS standards, and the U.S. Census of Ag. defines tillage differently. She is unclear about how to compare results from multiple sources. Nowatzke also appreciated Wall bringing up the difference in cover crops in i.e., planted vs. established. The survey information describes intent and how cover crops are being considered or tried out. If we are still seeing issues with establishment, on the biophysical side, remote sensing is telling us about the potential WQ impact. That gives us the social and the on-the-ground measure. Hopefully that can help us trouble shoot issues with cover crops especially if the numbers began to diverge. In response to a question from Wall about where Iowa has reconciled differences in results, Nowatzke said they are in the same place as Minnesota. She relies on experts at ISU to interpret OpTIS results. Because OpTIS isn't completely transparent it has been hard to understand what assumptions they are making and how that differs from other tools. Drewitz said BWSR has had conversation with OpTIS staff over the years. Because it is proprietary nature, it is difficult for them to share their methods. In a recent conversation with staff, Drewitz discovered they were overestimating no till in MN because the category was too wide. Nowatzke highlighted the transparency issue. How can a public entity share information that is based on proprietary methods?

From Wisconsin's standpoint, Craig said that the state is in the beginning stages of capturing satellite imagery tool in the manner Wall gave an overview on, particularly for reduced tillage, living cover, and EOF practices. DNR is working on specific protocols in HUC 12 watersheds that have an approved nine element watershed based plan. Satellite imagery is another method to better account for adoption rate in practices (both public and private). The other piece is using the Google Earth engine to create short cuts

to capture satellite imagery to speed up data collection. By standardizing the approach with free open-source software, more users can apply the technology. Right now, the focus is in the Upper and Lower Fox watersheds, around the Green Bay area that drain to the Great Lakes. DNR has formed a technical workgroup to standardize protocols. Once the pilot projects are up and running, DNR plans to expand to other parts of the state. Wisconsin sees utility in using satellite imagery.

Dan Zerr added that in the HUC 8 Red Cedar River watershed in NW Wisconsin, the annual report revealed that the state wide incentive of farmer-led council had twice as much no-till adoption as NRCS contracts. That speaks to the value of less red tape and more local and intimate interactions. More information can be found linked here: https://datcp.wi.gov/Pages/Programs_Services/ProducerLedProjects.aspx. Carpenter agreed that having farmer-led groups at the table with these nutrient reduction conversations is the key to moving the needle to meeting the goals of the nutrient reduction plans. In response to a question from Wall about targeting of environmental priorities, Craig replied that farmer-led councils have to meet certain criteria, but the practices of focus are determined by the councils. Some groups are focused on on-site inspections and soil health while others are more proactive about implementing cover crops and other practices.

Tyler Gruetzmacher said that Wisconsin counties have been conducting annual soil erosion transect surveys. A UW Madison grad student was working to figure out the system in which they started with Purdue survey software package and moved into SnapPlus. It may not be the best tool but it is more appropriate for 900 square mile county. Driving two people around is a three-to-four-day effort. Has any state taken it to a further level? Wall replied that transect surveys were used in a number of models. It was the best information on crop residues. Wall is hoping to rely more on satellite imagery data now and believing that it is an improvement. Drewitz added that Minnesota had completed transects for a number of years but made the decision to tradeoff to remote sensing data. Some counties in Minnesota are large, especially in the northern part of the state. It was additionally hard to get participation state wide.

Gruetzmacher asked if Minnesota is tracking combined data from the large corporations on turkey litter production and factoring that information into fertilizer sales. Like Minnesota, Wisconsin has a large turkey industry. Wall mentioned the environmental working group project, which observed a combination of fertilizer sales and manure production. Minnesota has pretty good numbers of animal registration database, but they struggle with turkey litter and transportation. It can move across county lines and we do not know where it goes after that. Gruetzmacher said it is a huge challenge in Barron County. In discussions with Jennie-O in 2020, a lot of the manure was shipped from Wisconsin to Minnesota. When that occurs, they can wash their hands of it in terms of reporting in Wisconsin.

Wall asked how other states are estimating progress on fertilizer efficiencies. Nowatzke answered that a few years ago, ISU partnered with Iowa Agribusiness. Agribusiness went to coops and retailers throughout the state and selected field records to collect information (via random selection) on the agronomic aspects of the field e.g., fertilizer application, crop rotates. Iowa Agribusiness provided ISU with aggregated values needed to extrapolate to the state wide level. This was a great example of a public-private partnership. In response to a question from Wall, Nowatzke said the biggest thing that came out of the effort was communicating about fertilize use, timing, and application methods. One big gap is that coops and retailers do not maintain records of manure application.

Craig described General Mills Regenerative Ag 2020 initiative:
https://www.generalmills.com/en/Responsibility/Sustainability/Regenerative-agriculture
and hopes that it leads to better capturing private sector conservation efforts.

Consistency across the Basin? - Should the HTF use a standard approach to track key practices across the whole basin? Or should each state figure it out on their own and report individually to HTF?

Wall added that each state has largely been figuring out this on their own. Should the HTF be using a more standardized approach across the Basin? Could the HTF have consistent measures and approaches? Janette Marsh mentioned her participation in the ecosystem and social indicators workgroup. The workgroup struggles to find a metric that fits across the Basin, even where data is uniformly collected. Even if the HTF could standardize its approach, the way states collect their data is going to strongly inhibit the possibility. It is not an easy thing to answer and Marsh would be happy to take any ideas back to the workgroup. Because hypoxia is of national interest, those involved in NRS are going to have to figure out a way to talk about some indicators and metrics across the Basin. Willhite said the HTF Action Plan is the focus of reducing hypoxia with set reduction goals. That is the ultimate metric that needs to be articulated to stakeholders and the metric by which the public will measure the states. Wisconsin also has a lot of difficulty on the agriculture NPS side, but it will continue to be challenging to communicate the progress on a state and basin wide basis if HTF states do not have similar data collection methods.

How useful/important are the local partnership efforts to accurately track land-use and BMP changes? Are there types of private information captured by private industry that could/should be obtained for larger scale evaluations in our states?

Willhite observed it is important to rally the troops as far as their commitment to conservation. Getting those local partnerships involved in measuring progress is really important. This includes private industry within the individual watersheds. Wall said he is excited about the partnerships beginning in Minnesota. They appear really promising in terms of carbon credits and market-based approaches. Kessler thanked Wall for his presentation. To follow up on Willhite comment's, she emphasized that states cannot do this alone or even at a regional level. If states are going to continue to incentivize voluntary conservation practice adoption, a much bigger pot of money is needed. She hopes that states are advocating for the infrastructure bill proposed by the White House or relaying the support to Congressional leaders. Coreen Fallat agreed that money for practices or incentives and funding to support technology to track progress are essential.

Monitoring Water Quality to Detect Changes in Nutrient Reduction

Mike Shupryt reflected that questions about how much time and effort should be put towards monitoring, coordination, and technical guidance came up when Wisconsin DNR was revising its strategy for watershed restoration work. Part of the shift came in USEPA 319 funding towards nine key element watershed plans.

Wisconsin has a good long term monitoring program for pollutants like TSS, TP, TN, and chloride that date back to the late 1970s. Those data demonstrate clear successes for TSS and TP in the UMR and inland rivers state wide.

Wisconsin does not have an abundance of success stories, and ultimately, they are important to continue to increase the social desire to engage in watershed restoration. The factors that go into success include engineering, social, and ecology. Shupryt believes that the reasons Wisconsin does not have more success stories include the following:

- Signal to noise
    - Lack of necessary density of BMPs
    - Inappropriate geographic scale

- Operations
    - Difficult to get pre-implementation data
    - Limited resources and larger geographic areas

- External factors
    - Outside partner funding sources
    - Private land owner implementation and confidentiality

In addition, Shupryt added another reason is inadequate monitoring and lack of experimental design to evaluate watershed restorations. State agencies can control these aspects. The statistical pieces to focus on for the best defense against an incorrect conclusion are percent change, sample variability, and sample size. Furthermore, with some costs associated, state agencies can employ techniques such as control sites, watershed wide analysis, concentration discharge relationships, and annual load monitoring.

For example, Wilson Creek watershed, a WQI watershed, utilized control treatment. This minimized the sample size and increased confidence in the percent change observed.

In Pleasant Valley, Wisconsin, the monitoring design was used to control for sample variability and flow. Analysis of Covariance (ANCOVA) was used to pick up the concentration-discharge relationship, changes in slope between discharge concentration relationship in a treatment site versus a control site.

Weighted Regressions on Time, Discharge, and Season (WRTDS) was used for the Sugar River, after DNR was asked to assess whether a 30-year effort to reduce conventional tillage rates had an effect. The river is a tributary to the Upper Mississippi River and is a 75% agriculturally dominated watershed. WRTDS attempts to remove the influence of discharge on a pollutant. This is, however, challenging with climate change and increasing precipitation. Weather is working against progress.

Shupryt shared his concluding thoughts on detecting change:

- Conduct a cursory power analysis

- Design a project commensurate with the restoration

- Think about control sites and covariates

Time and resources are extremely limited, but so are documented in stream success stories. Demonstrating success is import to sell more implementation.

Discussion

Steve Schaff recalled that on the last part of Shupryt's presentation he said that the model assumes that discharge varies around an average median value. The conservation practices Shupryt listed in the previous slide can have a significant impact on the discharge value. How does the model incorporate that variable? Schaff is interested in what discharge would be if no conservation practices were used, especially in terms of tillage and infiltration. Shupryt replied that the WRTDS model assumes that discharge is a proxy for precipitation, which is why it works well for TSS and TP that runoff the landscape in a predictable pattern i.e., precipitation measured as discharge. The modeler does not have to assume why precipitation is changing. It is in an interesting question, and perhaps for a smaller watershed you could be cutting off those peaks of high flow. The result may be a muted hydrograph, with fewer spikes in pollutants and discharge.

Kessler said Minnesota is struggling with a number of the same questions as Wisconsin. Since 2002, Minnesota PCA has delisted 53 waters. At the same time, the state agencies are doing a tremendous amount of monitoring at the 8-digit HUC scale, including continuous pollutant load and intensively at a much more granular scale. When you say we should do monitoring in a different way to show the success, Kessler agrees but at what scale is that? Kessler added she understands the need to continue the long-term trend network to feed into overall policy decision and balance that with granular EOF monitoring. What level watershed or HUC would you say you need to focus on in order to see the change at the intensity at you need to delist? Shupryt replied that it depends on the time commitment to that site. Is it a TMDL watershed where the implement NPS and BMP commitments are 30 years? With concentration of discharge over 30 years, trends will be picked up. If it is an agricultural watershed project that lasts around five years, it is probably less than a HUC 12. Kessler thanked Shupryt for validating what Minnesota has also observed. The big question is how to balance the need for long-term and intensive monitoring in certain locations at the frequency needed. Shupryt said Wisconsin DNR decided that EOF was not its role and to stick with WQ results. Kessler agreed it is not the state agency's core role, and the EOF is being done in partnership with researchers.

Gregg Good recalled that the Federal Clean Lakes program, Section 314, required spending for diagnosis. The feasibility study included bathymetric survey, sediment survey, etc. The spending was high for one year of data collection, all the while hoping it was a "normal" year. Phase two was to implement, and only a few hundred thousand dollars at most was granted. Good recalled it was not enough funding to implement. Finally, phase three was post restoration. Good has learned in his career to keep restoration monitoring simple, because it is difficult. John Hoke agreed with Good's statement and emphasized the balance and struggle between capturing long term trends while satisfying never ending data needs.

Martin Lowenfish asked Shupryt if Wisconsin has stories that can translate monitoring approaches to something that is more public friendly. For example, while a water body has not been delisted, it is showing good progress. Shupryt replied that the situation could be too complicated. In the previously mentioned Pleasant Valley example, TSS was reduced but only over certain flow ranges. The DNR fisheries team restored the area, and almost immediately they observed an increase in game fish. The area appeared aesthetically more pleasing. These pieces made residents more excited. It is important to tap into intermediate success stories, and understand what motivates the audience to get excited about a watershed restoration plan.

What prioritization approach do states use for monitoring nutrient reduction progress? Is degree of implementation in the watershed a factor? Why or why not?

Wieberg said that any time increasing resources for nutrient reduction monitoring is considered, stakeholders in the agricultural sector tend to be skeptical about the right amount of monitoring and whether resources should instead be focused on BMP implementation. In the case where there is a large degree of activity in the watershed, that does support an easier conversation with regard to monitoring because for the degree of implementation, there is a greater need to monitor and evaluate. From Missouri's perspective, DNR is resource limited and has to operate in the mode of chasing problems rather than balancing that with evaluating successes. Pam Anderson shared that Minnesota has focused monitoring at the outlet of major basin locations and at outlets of HUC 8 watersheds. There has not been as much focus on monitoring where there is BMP implementation. In areas of the state that are less impacted from agriculture, increasing nitrate trends are observed. Despite having the resources to equally monitoring watersheds across the states, the agency gets pushback on why monitoring is happening in less impacted areas of the state.

Schnieders said that in 2013 the Iowa NRS created priority HUC 8 watersheds for projects and practices. Iowa DNR's ambient monitoring network covers a lot of these watersheds and provides some baseline data. Observing potential changes will take time, however, and weather is a big factor impacting the

results. For that reason, the Iowa Nutrient Research center has looked at paired watershed studies with 1,500 acre watersheds to see whether practices are proven to improve water quality.

Have states found (or would they expect) that detecting a statistically significant change in water quality is (or would be) useful for promoting implementation in both the subject watershed and other watersheds?

Wall said that the answer may be in part a sociology question. Demonstrating success and confidence in the statistical analysis can serve as a motivator to rally together for change. Showing improvements in water quality, specifically phosphorus, is possible but nitrogen is more difficult. Does a statistically significant increase nitrate trend also motivate people? Wieberg said to continue on Wall's comment, it is all about what motivates stakeholders. Some may be motivated by statistically significant changes in the data, while others may not get it. Can you tell a story narratively (e.g., water clarity is as good as it has ever been) as well as from the data side of things? There is a waterbody in Missouri that is impaired, not for aquatic life, but because the criteria are more stringent. It is the clearest lake in the state, and the WQ is robust. Missouri will continue to struggle with those concepts.

Nowatzke said Iowa has thought about these questions a lot, such as managing expectations on how and when water quality changes can be expected, both with the public and amongst practitioners. This again emphasizes the need for communication surrounding success stories. Even if cover crops were put in on every farm, WQ improvements may not be seen for years. Developing the approach to statistical significance is really important to instill confidence to detect change and built public transparency and trust in the metrics. On the flip side, if WQ degrades, that will be detected as well. Schnieders added just because a result is statistically significant, does not mean it is real. Iowa has been concerned with the units used and the probability of confidence. Researchers have used Monte Carlo simulations to determine if the nutrient reduction goal was met for a project or practice. For example, if looking at loading alone there may be a 50% chance of seeing the signature in WQ data, but if flow weighted concentration is used, the probability is higher.

Anderson said even if WQ trends are significant, she struggles with teasing out the trend and on the other side to understand what is driving the change. For example, in north central Minnesota lakes, water clarity is improving because of zebra mussels. There are areas in the state where there is no WQ progress being made because the shift in climate is drowning out the changes. Anderson believes that the small-scale stories do more than larger WQ trends. Sample agreed with Anderson's comments and added that N and P are increasing in Illinois due to increased flow. In terms of WQ helping to drive implementation, Illinois does not have as many success stories, so a lot of that implementation has not been done at the scale need to drive change. Illinois relies on the Nutrient Research and Education Council (NREC) to present research at edge of field, demonstrating that practices work at field scale and results in nutrient reduction. That aspect is what the farmer can control. In response to a question from Fallat, Sample shared the link to learn more about the Illinois NREC: https://www.illinoisnrec.org/.

Gruetzmacher said that there are different groups to work with in promoting basin wide information and implementation. When working with farmers individually, he does not address large scale implications to the UMRB. Gruetzmacher and his colleagues look at a barnyard area and the field eroding. If there is a gully there before, let us get it fixed so it will not be there anymore. He emphasized keeping it basic and keeping conservation solutions localized for the farm. Having WQ data across the county would be nice, but it is not the main focus. Carpenter said from the perspective of getting landowner or producer to implement practices based on monitoring information, the key maybe to get the individual involved in the monitoring activities within their backyard. Farmers are ultimately motivated to implement practices from farmer-to-farmer peer networks.

Schaff asked if the states use continuous monitoring by deploying sensor technology to overcome the sample quantity issue. And does continuous data cause additional problems? Anderson said that Minnesota has tried a couple sensors for nitrate. They were very costly to purchase, and lightning destroyed one almost immediately. She will have to follow up if the data have been paired with implementation tracking or just serve as baseline monitoring. Good said that Illinois uses continuous monitoring primarily for load estimate leaving the state. The data are interesting but the quantity of it is challenging. Illinois EPA has had to manage millions of records and include that in their 303(d) list.

Schaff posed as a follow up question to states - while he understands monitors are expensive, is the spending commensurate to monitoring restoration efforts? In other words, are there enough data points to demonstrate an impact? Schnieders replied that Iowa uses many real time nitrate sensors for several purposes e.g., to calibrate load estimates and monitor restoration efforts. The scale of restoration and size of the watershed are important in designing a monitoring effort. The monitoring should be commensurate with the anticipated level of implementation expected.

Willhite thanked participants for the discussion. She would characterize from the wide-ranging conversation that monitoring is an important tool, but not the only tool in order to look at successes of nutrient reduction efforts.

Incorporating New Datasets

Adam Schnieders introduced the indicators of desirable change to realize nutrient reduction progress. Those indicators are inputs, humans, land, and water. In 2013, when the PS side of the Iowa NRS was being drafted, Iowa did not have enough P data and had to make engineering assumptions. Now the majority of facilities (151) are permitted and 31,000 annual P samples are collected. A challenge arose when the Iowa Legislature required that the Iowa NRS utilize the 1980-1996 HTF baseline. Estimating annual nutrient loads required using both modeled data and real data. Another example of incorporating new datasets was when Iowa was calculating state loading. The original analysis averaged three modeling tools: Linear interpolation, WRTDS, and LoadEst. Later, experts across the state got together and determined linear interpolation was the best fit. Iowa NRS authors had to justify the shift away from what was previously reported. However, there was not too much pushback because the decision was supported across multiple agencies and organizations.

Laurie Nowatzke elaborated on land dimension and social indicator examples. To illustrate challenges tracking conservation practices, Nowatzke explained how each dataset can either be a determinate, co-determinate, or corroborate an estimate off nutrient reduction. The main takeaway is that there are multiple data sources to draw from and the complexity arises when the data sources conflict with one another. Buffers are one practice that are particularly challenging, and Iowa does not have a reliable way to track implementation.

Cover crops have increased in use over the last decade. Between the survey of agricultural retailers, USDA census, cost-share plus crop insurance, and cost share acres, there are between one and two million acres of cover crops in Iowa. OpTIS is not officially being used yet, but also conflicts with the other above-referenced datasets.

The next example Nowatzke highlighted was the nitrogen fertilizer application rate, which combined private (agricultural retailer survey data) with public (NRCS) data. Using both datasets however, was like comparing different fruits. The survey recorded individual observations of nitrogen fertilizer application while the public data included state level data, paired down to the county level, including both manure and nitrogen usage over 1980-1996 and 2006-2010. Though challenging to combine, the results revealed that fertilizer rates have increased for corn-soybean, continuous corn, and manure application.

The final land dimension example is the BMP mapping project. This project was an extensive effort to map structural erosion practices seen through LiDAR and aerial imagery in 2010. To gain a sense of the change in practices over time, researchers looked back at samples of HUC 12 watersheds from the 1980s and 2016. The Iowa State statistics department helped extrapolate findings to produce a statewide estimate. There were privacy concerns dealing with the datasets, and gaining agribusiness buy-in was important. The last component is incorporating machine learning techniques to the existing database to apply to future LiDAR imagery.

On the social dimension side, Iowa State has distributed a partner survey every year since 2015. Questions include FTEs associated with water quality and nutrient reductions efforts within their organization, to describe funding programs, amount and source of funding, whether the funding is short term or sustained funding, and the primary product of the funding. The annual surveys allow funding to be tracked over time. Increases in funding are largely due to CRP rental payments. If you take that out, an increase in funding has come from the Iowa WQ funding initiative. However, the data are challenging to compare, for example, if an organization changes its funding structure and becomes harder to track.

The Iowa Nutrient Research Center is funding research to link social indicators with conservation practices to the social and administrative factors that determine success in small watershed projects. Some of the information collected includes what coordinators the project has or which partnerships were engaged. However, at the HUC 12 scale it is hard to get data at a resolution that is useable. The data collected have different collection scales and temporal resolution.

Discussion

Measure credibility - Many of the baseline numbers from which progress is tracked are based on limited information. What approaches have states used to ensure the comparison of broader baseline estimates to newer data rich value is workable?

Nowatzke cited an example on PS side with Iowa starting out with broader assumptions (i.e., modeled data) and replacing with data collected by PS facilities. Sample said for the PS side, Illinois set the baseline on 2011, the last year of data available, during the science assessment completion. Illinois did not use the 1990's estimate and utilized the baseline for NPS as well. Some PS data were available at that point, but there is a lot more now. Illinois is not going back to recalculate a baseline, because the additional data provide confidence in the dataset. In response to a question from Schnieders, regarding whether Illinois uses the HTF 1980-1996 baseline, Sample replied that it is complicated. The baseline was used to come up with the 45% reduction for target loading for the state for PS, agriculture and urban sectors. The load was the same for everyone. Then Illinois updated loading targets for 1997-2011 and broke those out by sectors. The numbers ended up being fairly close.

As a follow-up, Schnieders asked about PS phosphorus reduction efforts before 2011. Did Illinois have plans to reduce P before the baseline was set? And how did the state account for overall progress versus the facilities that were already doing reduction work? Sample replied that his understanding is that the early adopters implemented reduction measures around 2013-2014 timeframe, especially for the larger facilities in the Chicagoland area. On a statewide scale, the larger facilities make up the majority of the state's PS P loading. Sample agreed with Schnieders' statement that the PS accounting in Illinois captures the full account of reduction. Willhite also agreed that few facilities had to limit P, mainly because they may have been discharging to a lake. The bigger, statewide reduction was kicked off by the larger dischargers agreeing to do that.

In response to Schnieders' question whether Wisconsin uses the 1980-1996 baseline, Willhite responded that yes, the baseline is used. For P, a technology-based limit was used from 1992 and onward. There is a consistent dataset for PS P data. She does not recall if the baseline is articulated in the strategy on the

agriculture NPS and will follow up on that. Schnieders said the original NRS baseline for Iowa had certain reduction percentages for PS and NPS sectors. Then the legislature required the use of the 1980-1996 baseline, and Iowa NRS authors requested that the original strategy be retained as to not spend the time communicating why the percentages changed. Wall added that in Minnesota, the majority of the PS reductions occurred in the 2003-2012 timeframe. Now the state focuses on the 2000-2014 timeframe instead of the 1980-1996 baseline. With PS nitrogen, the information was not as good, and over the years, Minnesota has improved its N data collection. The loading back in 2000, with the exception of population and technology changes, were fairly similar to current levels. There has been less improvement in the state among facilities.

Communicating complexity – How have other states tackled challenges in communicating the various temporal and spatial scales of nutrient loss/reduction? How have they communicated the use of multiple datasets for individual metrics?

Nowatzke added that where Iowa has struggled is with critical audiences especially when the error or confidence intervals are wide. Iowa is documenting and communicating success stories, and using and water monitoring information and managing expectations when changes are seen. Wall said regarding groups that may be skeptical about OpTIS, that information about the tool is continually growing. Minnesota PCA works with its communication teams to simplify the messaging. By boiling it down to basic takeaways, the message to audiences is clear. Some of the messaging includes that P is decreasing but increasing flow and other climate change factors have counteracted progress; nitrogen is increasing, but watersheds working to reduce their fair share can help achieve the reduction goals; emphasize milestones made from the first half of reduction and do not get too hung up on the long term. Wall said that research and development can provide new avenues.

Wieberg said the communication challenges are the same across Missouri DNR's water quality work e.g., 303(d), WQ standard amendment. The topics are complex. You can use a WQ related research paper to support your decision one way and a group can use the same paper to show that you are wrong. You need to know which stakeholders to convince. Others look to the key people to take their cues. Meeting with those influential folks early is critical to gage any reactions, whether it be fear or skepticism, that could be tied to a lack of information or a communication problem. State agencies need to be versed in the practical implications of a policy or program change and relay those messages to audiences e.g., farmers.

In response to Schnieders' question about insights communicating complexity at USEPA, e.g., hypoxic zone size, communicating temporal and spatial scales, Flahive first emphasized how informative the workshop has been for her, to listen to the level of detail. She does not typically get the opportunity to do that. That being said, communication is really hard, and what the HTF is trying to accomplish through its workgroups is communicate the complexity. Up until this point, USEPA communicated about the size of gulf hypoxia, and once the Fennel and Laurent (2018) paper came out, it honed in on a nutrient reduction target. It lined up conveniently with the goal of the HTF and gave us feet to stand on, both in the approach the HTF is taking and the way progress is communicated. USEPA relies on those national level peer reviewed modeling efforts and communicating the progress and the stories of the HTF states.

Nowatzke said there is a limiting factor on science communications. Iowa has specialists in respective agencies and organizations but it does not feel like we have enough of them. What skillsets are the game changers for states? Flahive deferred to Salvato and Justin Sherwood, co-chairs of the HTF communication workgroup. Salvato said that the starting point of the workgroup was to figure out who the state agency communications staff are and clarifying what their role is with the NRS. The co-chairs compiled a survey and distributed it to the POCs asking what they are doing well with regard to communicating about the NRS and what is not going very well. While still in the data collection phase, Salvato said that initial results suggest that states want to improve public understanding of the NRS and on the farmer side, states wish to improve farmer awareness of state and federal programs for

conservation practice implementation. The workgroup hopes to build off the aspects that are going well for states and share those resources with other HTF states.

Carpenter asked how many states have partner led organizations as groups or members of their nutrient reduction advisory team that help assist with writing the state's plan and updating the plan. If there is such a team in your state, does it help with communication? Drewitz said Minnesota BWSR has a staff person who is a former newspaper reporter. She has helped on the quality of their stories: http://bwsr.state.mn.us/clean-water-fund-stories. Schnieders said Iowa has farmer leader organizations integrated into the NRS that help as key implementers. Once they are integrated in the process, they take a lead in helping implement the strategy. Wieberg said that Missouri does as well and includes organizations like Missouri Farm Bureau, Missouri Corn, and Missouri Soybean representatives. Willhite said that Wisconsin does not have a formal advisory team. However, there are 20 farmer led watershed groups that are doing the promotion of conservation, education and outreach within their respective watersheds.

Exploring the utility of various data collection approaches – When is it appropriate to use survey data, public administrative data, remote sensing data, etc. for tracking practice adoption? What are some limitations, gaps, and challenges that other states have encountered with one data collection approach or another?

Nowatzke said that OpTIS is a good example. Has any state had to reject a data source for any particular reason?

Wieberg says Missouri struggles with sending PS data to the Enforcement and Compliance History Online (ECHO) federal database. Missouri has its own system and utilizes it to the best of their ability. There are data accuracy challenges that are always being fixed within USEPA e.g., a PS facility that is no longer online but still shows up in the database. Further complicating the issue, entities use publicly accessible data to analyze progress and the state can end up with the short end of stick because not all of the available data is utilized.

Drewitz said his data challenge is with cost share practices, BMP location data, and information from grants databases. If databases themselves have been improved or quality assurance/quality control (QA/QC) practices, then data from 15 years ago is not as good as new information. Even BMP's dating back to the 1990s cannot be used. The state is now working on the next generation of the database and Drewitz hopes it will not have the same challenges as previous database improvements. Database management is an ongoing issue, but overall, the state is doing better QC with local government partners, and more data are added that is comparable.

In response to a question from Schnieders about Minnesota's buffer law, Drewitz said there are a few tracking tips states may find useful. Minnesota developed on an online ArcGIS application that SWCDs had access to. They utilized a tool called BuffCat to map out the buffers and if they were compliant. The benefit of using the tools is that all the data are in one place and have a geospatial tie, and the software is relatively inexpensive to maintain. The data are private as practices funded and easement data are also included in the database. In response to a question from Schnieders, Drewitz said you can think of the data collection as being crowd-sourced. Either SWCD or a local government unit is responsible for monitoring and enforcement of the buffers.

Willhite said she is interested in hearing states' thoughts on when it would not be appropriate to use survey data. Wisconsin relies mainly on public administrative data and therefore does not have consistent data collection between DNR and the Wisconsin Dept. of Agriculture, Trade, and Consumer Protection. As far as collating and managing data, Willhite does not know if the agencies have the ability to include those pieces. Unless told it is unwise to do so, all data sources may be utilized.

Sample said to follow up on Wieberg's comment, he wants to drill down on how everyone is using PS models and tools. Illinois does not have the most efficient system but he is confident in the datasets from a QA/QC perspective.

In terms of what data are appropriate to use, it depends on the consensus of stakeholders, and for Illinois it is the policy working group. The working group agreed to have a mass survey for Ag BMP data. OpTIS has been brought up and discussed, but there has not been movement to adopt it. Looking at the multiple datasets, Illinois Fertilizer and Chemical Association survey that help clarify questions on the retailer side of fertilizer management.

Illinois bases its state wide cover crop number on the results of the National Agricultural Statistical Survey (NASS). When farmers come in to certify their crops, they can confirm this information with their Farmer Service Agency (FSA) office. Illinois can get the information at a county and watershed level. From Sample's perspective, the data are reliable and inexpensive to acquire. The problem is that not all farmers report this information or know that they are supposed to. Outreach to local offices was increased in the form of newsletters and emails. In the future, Illinois would like to rely on the data over satellite data.

Nowatzke mentioned that Iowa FSA offices were trying to implement a similar data collection effort, and she will look into it. Wall said that Minnesota has not looked into it. He agrees with other's thoughts. It is early in the game to land on one approach to data sources. All approaches have pros and cons and it is important to reflect on what is being learned from the various approaches. For example, Minnesota has been trying to collect soil phosphorus data from private industry and laboratories. However, the sample is not random and PCA has to provide the explanation in progress reports.

Schnieders concluded that there is a lot of work and a lot of effort to get to the scale where improvement is realized. He encouraged everyone to keep persistent especially at the size of the states and the scale of change to effect.

Next Steps

Salvato said she will convene with the planning committee again regarding another set of workshop sessions. Stay tuned for additional information, in the near term a recording and informal survey will be sent out to request additional topics and feedback for workshop playing and layout. In the months following, UMRBA will put together a workshop summary.

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