Interim Progress of the Yahara Watershed Adaptive Management Pilot Project

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Evan Childress, Samuel Christel, Kara Cromwell, Andrew Hasley , Benjamin Kraemer, Alexander Latzka, Alison Mikulyuk, Carlos Ramirez Reyes, Jennifer Raynor, Jennifer Stenglein, Jacob Usinowicz, Jake Vander Zanden, Jacob Walsh

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

This report was completed as part of a course in "Collaborative Approaches to Problem Solving" in the Zoology Department at the University of Wisconsin-Madison in coordination with the Wisconsin Department of Natural Resources (WDNR), the Madison Metropolitan Sewerage District (MMSD), and the Dane County Conservation Division (DCCD).

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Executive Summary

The Yahara Watershed Improvement Network (Yahara WINs) is exploring implementation of the adaptive management regulatory option (AMO) to improve water quality. At its core, the AMO supports reduction of phosphorus pollution through partnerships between point and nonpoint phosphorus sources. Our goal was to conduct an outside and independent interim audit of the program in the second year of its four year term.

Our review of the AMO pilot project suggests that the AMO will be significantly less expensive than brick and mortar alternatives. Focusing BMPs on three of eleven pilot area subbasins with the highest P loss reduction potential has the capability to achieve the project's ~3500 lb/year P reduction goal. However, winter manure spreading causes a large proportion of total P loss, and addressing this should be a top management priority. Additionally, estimation of the reduction in field-level P loss due to BMPs should be completed in advance of implementation, so that sites with the greatest potential to cost-effectively reduce P loss can be prioritized. Finally, we recommend P loss reduction be verified by edge-of-field monitoring at sites representing key BMPs for the watershed.

Although the site-specific criterion has not yet been developed for Badfish Creek, support from the DNR and EPA for the AMO is strong. Success of the AMO will depend on the Dane County Land and Water Resources Department's continued cooperation with the Clean Lakes Alliance and Yahara Pride in their effective brokering of the AMO pilot project.

Yahara WINs has a good track record of engaging partners from nonprofit organizations, regulatory agencies and point sources. Engagement of nonpoint producers remains a challenge, and we recommend continued emphasis on communication with this community.

Overall, significant progress has been made toward meeting the objectives stated in the MOU. However, current BMP implementation is based on voluntary participation and unknown P reduction potential. The pilot project and full-scale implementation will be most likely to hit the P reduction target if it employs strategies such as reverse auctions and other BMP targeting approaches that are specifically designed to minimize cost per pound of P reduced.

Introduction

The Wisconsin Department of Natural Resources (WDNR) has established effluent standards and limitations in an effort to reduce the amount of phosphorus (P) discharged to Wisconsin's surface waters (Wisconsin Administrative Code NR 217). To meet these standards, point source contributors of P have traditionally constructed "brick and mortar" solutions that depend on technological innovations to control the amount of P in effluent. However, meeting current water quality standards with brick and mortar solutions can be costly. Under certain conditions, NR 217 allows for regulated point sources to achieve these standards through creating a watershed adaptive management option (AMO), authorized by the WDNR, to comply with water quality criteria (e.g., TMDL). This enables point sources to achieve compliance by collaborating with other P sources to reduce the overall loadings in the watershed using cost effective solutions.

In partnership with stakeholders in the Yahara watershed, the Madison Metropolitan Sewerage District (MMSD) has initiated the Yahara WINs pilot project to evaluate the potential advantages of implementing an AMO in the entire Rock River Basin. A major objective of the Yahara WINs pilot project is to identify agricultural best management practices (BMPs) that represent cost effective alternatives to brick and mortar solutions for reducing P in the Yahara Watershed. Examples of BMPs being explored by the pilot project include cover cropping, manure injection and winter manure storage.

Almost two years into the Adaptive Management Pilot Project, it is important to evaluate its progress and effectiveness. If the pilot project is successful, it should demonstrate that the AMO can be scaled to the entire Rock River Basin. As a part of a 1 credit graduate seminar entitled "Collaborative Approaches to Problem Solving," a group of 12 University of Wisconsin–Madison (UW) graduate students have set out to do the following: 1) audit the current progress of the AMO pilot project and 2) determine whether scaling up the pilot project to a full-scale AMO is likely to be a successful alternative to traditional P management.

Evaluation of the pilot project follows the format of section 6 or the "Evaluation of Pilot Project" section of the Adaptive Management Pilot Project Memorandum of Understanding (MOU). Here the participants of the MOU lay out a framework for gathering information during the pilot project to inform their decision on the full-scale implementation of the AMO in the Rock River Basin. Seven factors were considered in the evaluation of the pilot project: Cost and Affordability, Technical Feasibility, Administration, Partnerships, Regulatory, Community Acceptance and Net Environmental Benefits. Each is addressed in the following sections of this document. Our goals are to provide the parties involved in the MOU with an independent, outside evaluation of progress to date, and to make recommendations on how to proceed toward scaling up the pilot project.

A. Cost and affordability

i) Whether adaptive management represents a cost-effective option based on experience gained during the pilot.

Assessment

A major goal of the AMO is to determine the cost of practices employed to reduce P. Cost effectiveness is determined by comparing costs associated with the AMO to brick and mortar alternatives. We adopt MMSD's expected infrastructure costs as a target value against which to compare the AMO, since they are expected to be the largest among all point sources in the watershed. Thus we can conclude that the AMO is a more cost-effective option overall if it is more cost-effective than the MMSD infrastructure project.

Costs for a brick and mortar addition to the MMSD wastewater treatment plant are based on target P effluent concentration. The most appropriate targets are 0.13 mg/l and 0.075 mg/L. At these concentrations, annualized costs per pound ($/lb) of P are expected to be $151 and $181 respectively, or a total of $78 and $124 million PW (present worth) (Table 1). In contrast, *a priori* analyses predicted that the AMO would cost a total of $59 million PW, of which point sources would be responsible for $30 million. Our goal here is to assess whether the *a priori* estimates appear realistic based on the current experience. Below, we summarize expenditures on P reduction to date, estimate the least cost path for P reduction based on model results, and compare AMO costs to the expected brick and mortar P reduction costs.

Target Concentration (mg/l)	Annual P Reduction (lbs)	20 Yr. PW Cost (Million $)	Annualized PW Cost (Million $)	$/lb. of P
0.225	11,415	$ 71	$ 3.6	$ 311
0.130	25,875	$ 78	$ 3.9	$ 151
0.075	34,246	$ 124	$ 6.2	$ 181

Table 1. Costs for MMSD brick and mortar additions at varying target P concentrations. Costs are presented in terms of total cost over the duration of the project, annual project cost, and cost per pound of P reduction.

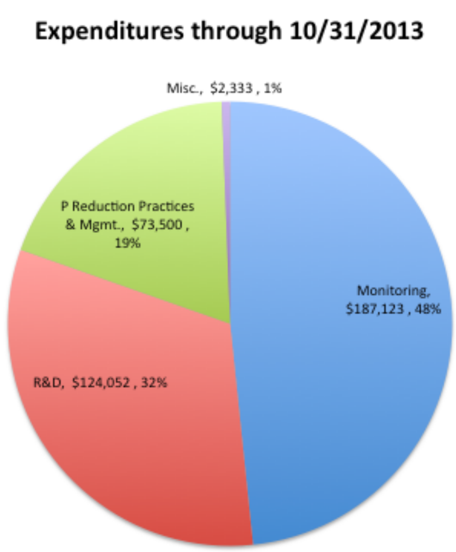

Figure 1. Total expenditures made by Yahara WINs through October 2013. These expenditures reflect the early stages of this project, with only a minority of funds being spent directly on P reduction practices.

Total direct expenditures for the AMO by Yahara WINs through October 2013 were $387,000; 48% of expenditures was for monitoring, 32% for research and development, 19% ($73,500) for P reduction practices, and 1% for miscellaneous expenses (Figure 1). In addition, Yahara WINs has contracted $30,000 to Dane County for a manure digester reverse osmosis study, which has not yet been invoiced. Overall, this spending pattern is consistent with the pilot project objectives outlined in the MOU, which focus heavily on gaining understanding of the system through monitoring and research as well as on building capacity for later P reduction projects.

Total P reduction from all projects in the pilot watershed was 3,438 lbs from 2008 (the baseline year for the Rock River TMDL) through the launch of the pilot project in 2012. Most of this reduction was the result of roof runoff structures, heavy use area protection, and nutrient management. Since 2012, there has been 1,111 lbs of P reduction formally measured in the watershed; corresponding practices were paid for by Yahara WINs, Dane County, and/or Mississippi River Basin Healthy Watersheds Initiative (MRBI)/Environmental Quality Incentives Program (EQIP) funds. Other practices have been installed in the watershed during the same period but have not yet been cataloged by Yahara WINs. Notably, in 2013 Yahara WINs paid Yahara Pride farmers $70,000 to conduct demonstrations on P reducing practices including cover crops, vertical manure injection, vertical tillage, and strip tillage. Implementation of these practices on the approximately 3,380 acres of demonstration sites is expected to reduce annual P loss by 1,690-3,380 lbs., with average cost ranging from roughly $21 to $42/lb of P. Further, in 2012 Dane County, Yahara Pride and the Clean Lakes Alliance funded a cover crop demonstration project in the upper part of the Yahara watershed, which is expected to result in a P reduction of 425 lbs at an overall cost of $80/lb of P. In summary, expected total P reduction is 3,226-4,916 lbs. since the start of the pilot project and 6,664-8,354 since 2008, resulting in an average cost to Yahara WINs of $46-58/lb. These costs likely will not be representative of the full AMO project because current Yahara WINs expenditures have been dominated thus far by ramp-up costs rather than P reduction activities.

It is possible to estimate bounds on the long-term expected cost effectiveness of the AMO by using a combination of published literature and models. We calculated expected maximum cost of P reduction in the pilot project subbasins using the estimated annual total maximum potential reductions in P loss in the pilot area (based on the Montgomery Associates SWAT modeling, Appendix E; see Technological Feasibility below for more details) and the published linear relationship between P reduction and BMP expenditures (Maxted et al. 2009). The expected cost of P reduction for the pilot project ranges from $57 - 198/lb P. Yahara WINs may not achieve the least cost AMO path, because the most cost-effective BMPs would need to be universally accepted by producers in the watershed. However, it is likely that enough low cost options exist (see Recommendations and Technical Feasibility section below) to achieve an overall cost per lb of P that is less than the expected brick-and-mortar costs of $151-181/lb. *Therefore, the AMO likely is a cost-effective alternative to traditional remediation.*

Recommendations

Our best estimates indicate that the AMO is expected to be significantly less expensive than brick and mortar alternatives. However, the cost-effectiveness of the AMO depends on implementing BMPs that are effective at reducing P, inexpensive to implement or maintain, and likely to be widely adopted. The bounds on our estimates of cost-effectiveness are large, ranging from highly cost-effective (i.e. $21/lb P estimate from implementations prior to the Yahara WINs project), to not cost-effective ($198/lb P worst-case scenario estimated using modeling results). Much of this variability results from the scale of implementation. This means that widespread implementation of specific BMPs will be essential for making the AMO cost-effective. Thus we recommend pursuing the AMO as a cost-effective solution.

Although farmer participation cannot be guaranteed, it is important to pursue BMPs with the highest P retention per dollar. The proposed P reduction reverse auction is a critical tool to identify highest value BMPs and build farmer participation. Efforts to increase awareness of the auction and to aid producers in estimating P reduction costs should be highly prioritized.

As a final caveat, we wish to emphasize the huge potential gains that could be made by focusing on winter manure spreading. The models we used to project the average subbasin cost do not incorporate the effects of winter manure spreading. The P contribution of winter manure runoff can be as much as 50% of the total annual P input to waterways (Lathrop and Carpenter 2013). Incorporating BMPs that target this source of P loss are critical for the ultimate goal of reducing P load and may substantially affect the project's cost-effectiveness and ultimate success. Research on cost-effective manure management practices should be highly prioritized.

ii) Whether a sufficient level of local, state, federal, foundation and other funds have been committed to, or can be reasonably expected to be committed to the Yahara Watershed to support nonpoint BMPs.

Assessment

The full AMO is expected to cost $59 million PW, representing an annualized present worth of approximately $3 million. If costs are split proportionately based on phosphorous reductions required by the TMDL, then point and nonpoint sources each become responsible for approximately $1.5 million. At present, a variety of sources have committed funds towards both point and nonpoint costs for P reduction. The three most significant are Yahara WINS, Dane County, and the Clean Lakes Alliance (CLA) (Table 2). Dane County is the largest potential source of funds. Some of this money has been approved directly for P remediation (e.g. $750,000 for Yahara CLEAN implementation), but large quantities are also found in more general lake preservation funds (e.g., $2 million in the Lake Preservation and Renewal Fund).The approximately $600,000 available through Yahara WINS represents municipal governments and nonprofits. The approximately $800,000 available to the CLA comes from a variety of private sources, including individuals and corporations.

Funding source		Amount
Yahara WINS		**596,000**
	Sand County Foundation	164,000
	Mou Participants	432,000
Dane County		**6,070,000**
Clean Lakes Alliance		**789,783**
	Programs and Sponsorships	341,129
	Individual	34,680
	Corporate	158,792
	Grants	76,500
	In-Kind	178,682

Table 2. Summary of major nonpoint funding sources in 2012-2013.

Recommendations

The funds which have been accounted for during 2012-2013 meet or exceed the $3 million targeted for the AMO. These funds come from a variety of sources and represent multiple interests, including municipal, agricultural, private and corporate. One of the biggest challenges for assessing whether sufficient support exists is simply in accounting for various forms of support. At present there appears to be no centralized accounting entity that can track investments made by different entities. We recommend that MOU participants forge a more explicit data sharing agreements with other players working towards P reduction in the region to track both expenditures and lbs of P reduced throughout the region.

B. Technical feasibility

i) Whether the pilot demonstrated from a practical standpoint sufficient BMP capacity exists to support the required phosphorus and total suspended solids reductions.

ii) Whether the monitoring and modeling results demonstrate reasonable potential for water quality improvements and eventual attainment of water quality standards.

Assessment

We assessed whether current soil monitoring and modeling efforts indicate that sufficient BMP capacity exists to support the required P reduction. A baseline of annual P loss at the subbasin level was established using SWAT model results and soil P. Potential reductions in P loss from fields was estimated using SnapPlus. These P reduction estimates encompass both minimum and maximum attainable reductions, based on either modest or maximum implementation efforts of two sets of BMPs: manure management and in-field actions. Using the 11 subbasins of the pilot project we used these data to place upper and lower limits on the total P reduction potential of the pilot project, and show that BMP implementation efforts can be focused by ranking subbasins according to P loss, P loss reduction potential and cost per pound of P loss reduced. Results suggest that modest implementation of both manure management and in-field actions fall just below this goal, but maximum implementation greatly exceeds this goal (Figure 2).

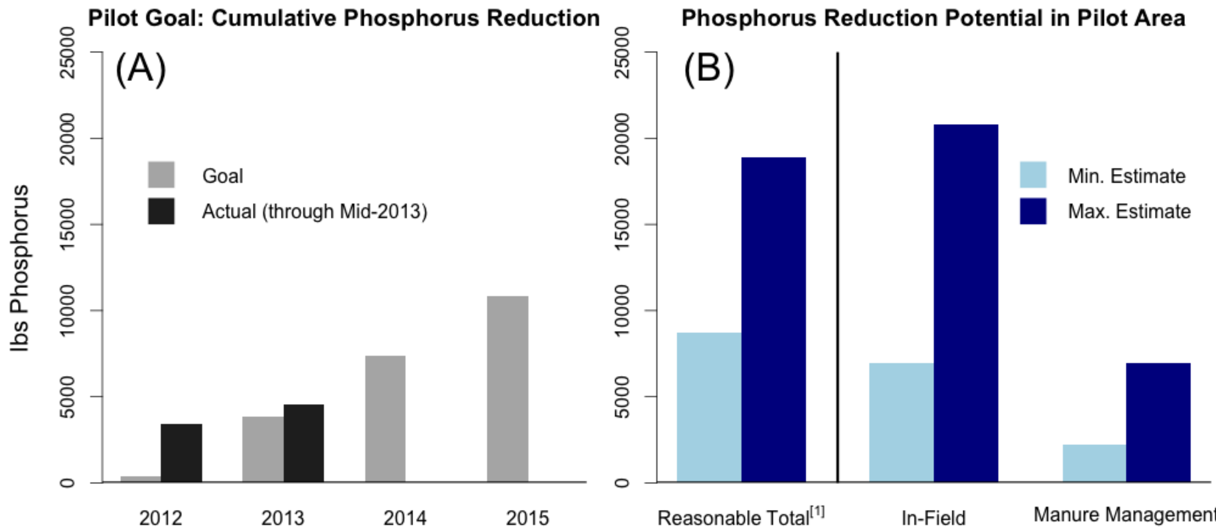

Figure 2. The annual phosphorus load reduction goals of the Yahara WINS pilot project (A) compared to the minimum (light blue) and maximum (dark blue) projected annual P load reduction potential of subbasins located within the pilot project area. Actual reductions to date appear in solid black bars in panel (A). [1] The “Reasonable Total” is based on a realistic combination of in-field and manure management P reduction practices rather than the simple total of the two BMP categories located to the left of the vertical line in (B).

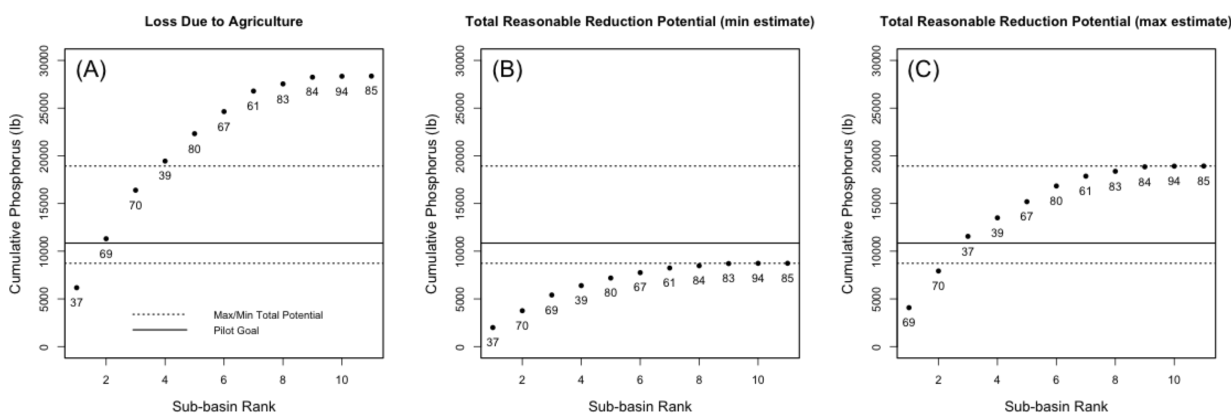

Figure 3. Yahara WINs subbasins ranked by P loss (A) and by the projected minimum (B) and maximum (C) potential P loss reduction. These plots provide a means of prioritizing BMP implementation.

Ranking the 11 subbasins indicates that a substantial amount of reduction can be achieved by focusing on 3 subbasins in the pilot watershed (IDs 37, 69, and 70) . Figure 3 shows the cumulative P lost as subbasins are ordered according to their total P contribution to waterways, along with the cumulative reductions possible as they are ordered according to potential P reduction. The subbasins in the lower left corner of the graphs show the ‘priority’ subbasins where BMPs would be most effective. These subbasins also represent the some of the lowest estimated costs per pound of P reduced (Figure 4).

Recommendations

The goal of ~3,500 lbs P/yr through 2015 is technically achievable and reasonable in the subbasins within the pilot project; the reduction goal lands reasonably within the bounds of minimum and maximum potential. The existence of "slack" in the system implies that, theoretically, farmer participation need not be ubiquitous for the project to achieve its P reduction goal. However, participation of farmers with the largest losses is critical for achieving the target P reductions, since the most effective way to reduce P involves targeting both individual fields and subbasins with the highest P loss reduction potential (Diebel et al. 2008). We recommend that BMPs be focused on fields and subbasins with with highest P loss reduction potential (Figure 3) and lowest estimated cost per pound of P reduced (Figure 4), such as subbasins 37, 69 and 70. Additionally, this subbasin level analysis may aid in field specific prioritization efforts (e.g., subbasins 37, 69 and 70 may contain cost-effective and high potential P reduction fields). This is developed further in section G (Net Environmental Benefits).

Lathrop and Carpenter (2013) highlighted the importance of P loading from fields, sediment, and wetlands from winter storm events, and note that SWAT does not account for this. As a result, both the P loss and P loss reduction estimates of fields are likely underestimates. This limitation of previous modeling efforts highlights the importance of incorporating winter storm event loading into model development.

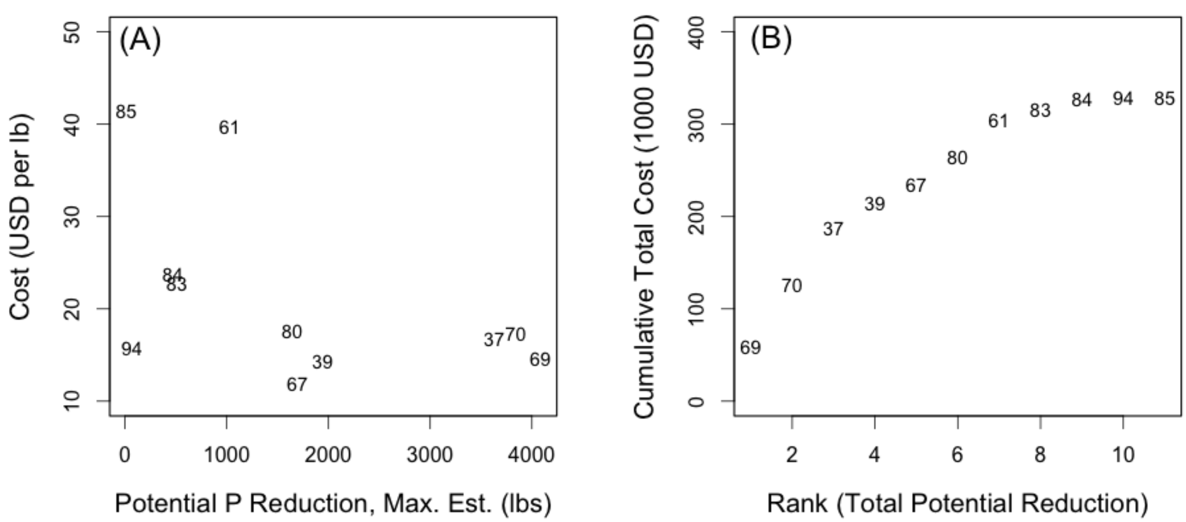

Figure 4. Total potential reduction (x-axis) and P reduction cost efficiency (y-axis) are likely to influence the prioritization of Yahara WINs' efforts (A). Total cumulative cost for subbasins ranked by P reduction potential is presented in panel (B).

C. Administration

i) Whether the county and/or another entity can effectively fill the role of broker.

Assessment

Dane County Land and Water Resources Department (LWRD) serves as broker for the AMO. The county uses model outputs to identify P sources and estimates reductions in P loading likely to result from the implementation of BMPs. Dane County anticipates completing an inventory of conservation practices for 81% of cropland acres in the pilot watershed, which would meet their goal to inventory 70% of agricultural land in the pilot project area (Kyle Minks, *personal communication*). Dane County LWRD staff continuously work with landowners on BMPs and have established relationships with 90% of the producers who operate approximately 85% of the cropland acres in the pilot watershed (11,000 acres in total). The county also facilitates financial transactions, connecting farmers to funding sources. Dane County previously secured $1.97 million for BMPs through the priority watershed program, but participation through the Mississippi River Basin Initiative grant is below expectations. Multiple ongoing initiatives in the watershed may explain low participation under the MRBI grant.

Successful implementation of BMPs involves ongoing contact between farmers and county staff over many years. The Dane County Land and Water Resources Department has established relationships with many farmers in the pilot watershed. The county is well-suited to build on previous successes and broker the financial transaction between point and nonpoint P sources in the AMO. Moreover, Dane County works with Yahara Pride and the Clean Lakes Alliance to increase farmer participation. Yahara Pride and the CLA facilitate BMP demonstrations (e.g. vertical manure injection, vertical tillage and strip tillage) that help engage producers that may be reluctant to work with the county.

Recommendations

Dane County LWRD has intensified work in the pilot project area and has demonstrated their capacity to act as broker. However, additional projects must be implemented in order to meet the pilot project P reduction goals. The ability of Dane County LWRD to fill the increased demand for staff hours should be critically evaluated; additional staffing may be required.

The broker will rely on farmers to set the price of their planned BMPs. We recommend that strategies and assistance be made available through an impartial third party on a contractual basis; the Clean Lakes Alliance and Yahara Pride have been valuable partners that help increase farmer participation. If targeting BMP implementation to optimize P reduction efforts becomes a priority, involvement of non-governmental entities can play a pivotal role in fostering strategic P reduction.

ii) Are contracts or other legal tools used in the pilot effective in maintaining adherence to BMPs on the part of the credit generator?

Assessment

Dane County Land and Water Resources Department have demonstrated their capacity to enforce BMP contracts and ensure BMP implementation. Current cost share programs have a 10 year maintenance period and the LWRD performs yearly checkups until BMPs are well-established. After BMPs are well-established, checkups are less frequent, and the responsibility for maintenance shifts to the producer.

Recommendations

We recommend delineating a schedule of adherence checkups, yearly through establishment, then every other year thereafter. Because P reduction for 2013 is below pilot project goals, increased BMP implementation in 2014 and 2015 is required to meet pilot project targets. This may require the county to increase the number of work-hours to serve as broker for the AMO.

D. Partnerships

i) Whether a sufficient number of partners have agreed to participate in a full-scale project and whether the level of participation is sufficient to reasonably expect that a full-scale project would be successful.

Assessment

The opportunity to develop partnerships among diverse stakeholders is a key advantage of the adaptive management approach. Yahara WINs has a track record of success for participation and partnership development among regulatory agencies, point sources and nonprofit partners. For example, with two exceptions (Town of Madison and City of Sun Prairie), all point sources identified in the Rock River TMDL as having both a Yahara watershed discharge and P reduction requirement are participating in the pilot project.

Participation from the nonpoint sector remains the central challenge. Dane County LWRD staff are actively seeking rapport with producers in the pilot watershed, and have working relationships with a large majority (~90% of producers, operating ~85% of acreage in the pilot area). There is a history of P reduction practices in this portion of the watershed and corresponding P data are likely available for much of this acreage. Nevertheless, only 8 producers (~23% of cropland) have consented to provide Dane County with PI information for the use of the pilot project to date (Kyle Minks, *personal communication*).

Although relationship development may be the *sine qua non* for recruiting producer participation in a full-scale project, the success of the project in terms of P reduction will depend on producers participating sufficiently in BMPs. To achieve P reduction goals for a full-scale project (i.e., 150,000 lbs P/yr) target participation should be approximately 1200 producers (based on average land holdings of 122 ac/producer in the Yahara Watershed; Kyle Minks, *personal communication*). This suggests that 80% of the 1500 producers in the Yahara watershed should collaborate with YaharaWINS to implement BMPs if P reduction goals are to be met for a full-scale project. If producer participation in the full-scale project were to scale linearly from their current commitment to the pilot project, participation would be insufficient for a full-scale project to succeed. However, if agricultural partners were targeted to implement BMPs based on a prioritization scheme (e.g., see section B above) it is likely that fewer participants would be required to meet targets. MMSD is working with collaborators to achieve more precise and spatially-explicit assessments of costs and benefits of various conservation practices, which could ultimately refine estimates for target numbers and locations of participants.

Recommendations

The gap between the number of producers in the pilot who possess P data and those who have been willing to share it suggests that engaging producers to transition from "entry level" participation in the project to more committed involvement could be an ongoing challenge. Because high participation from nonpoint sources is required for successful P reduction, there is a clear need for communication strategies to engage agricultural participants. Tailoring these strategies to a particular subset of producers would be crucial for implementing any optimization or prioritization scheme within the watershed (see Section F, below).

As an example of successful partnership development in the nonpoint sector, YaharaWINs has fostered a close relationship with Yahara Pride during the pilot project. However, to achieve adequate participation in a full-scale project, either YaharaWINs should continue to cultivate additional communication strategies for engaging the large number of new participants required for full-scale implementation, or Yahara Pride must substantially grow its membership (from the estimated 50 registered members) if it is to remain a primary means of communicating with producers. Advancing the overall communication strategy could include continued collaboration with Dane County to tailor a clear message that conveys the advantages of adaptive management to producers (see Section F). Highlighting potential financial benefits of conservation practices is likely to be very important for encouraging participation; however, because financial incentives *per se* are not what distinguishes the adaptive management approach from other P reduction schemes, partnerships would ideally be encouraged within a framework that integrates the potential financial, social and environmental benefits of adaptive management.

Finally, participation currently takes several forms, which are more-or-less effective for meeting P reduction goals (ranging from attending meetings to providing information for baseline assessments, to implementing BMPs). Therefore, evaluating participation for the purpose of MOU success criteria will require explicitly defining what constitutes meaningful "participation" and quantifying it in terms of P reduction potential.

E. Regulatory

i) Whether regulatory barriers have been removed (e.g., has a site-specific criterion for Badfish Creek been developed and implemented).

ii) Whether additional regulations that have been developed or are anticipated are a deterrent to pursuing a full-scale adaptive management project.

iii) Whether DNR and EPA still support the adaptive management concept.

Assessment

MMSD discharge to Badfish Creek exceeds the current water quality criterion of 0.075 mg P/L. To avoid being limited to brick and mortar solutions in the short term, MMSD needs a site-specific criteria for Badfish Creek that would put them in compliance with state water quality standards. Site specific criteria are allowed by NR 105, but DNR has not yet codified the procedure for developing site-specific criteria. This is a work in progress that is unlikely to be complete before the drafting of the AMO plan. In the absence of a codified procedure, site-specific criteria must go through a five-step development process involving the DNR, the Governor, and the National Resources Board (NRB). The DNR must first develop the procedure they will use to set site-specific criteria before determining whether to recalculate the standards for Badfish Creek, although criteria are likely to be set with reference to instream concentrations of chlorophyll-a. Regardless of the procedure ultimately adopted by the DNR, granting of a site-specific variance is more likely if Badfish Creek shows no sign of biological impairment.

The uncertainty over whether or not a new site-specific criterion will be successfully developed adds risk to MMSD's decision to participate in the adaptive management option. However, money spent on adaptive management may result in improved water quality, which may then lead to the calculation of less stringent water quality-based effluent limits that would require less expensive brick and mortar solutions.

The DNR and EPA appear still to support the adaptive management option. Both agencies recognize the potential of adaptive management and the experimental nature of the approach. If the DNR approves the Adaptive Management Plan, the interim effluent limit for the first 5-year permit term will be 0.6 mg/L, decreasing to 0.5 mg/L in the second permit term. MMSD is likely to achieve compliance with interim effluent limits. Ultimately, the DNR is more likely to approve the adaptive management plan if it can be demonstrated that reducing the P concentration to 0.075 mg P/L does not have compelling biological benefits for the stream, or if there is no evidence of biological impairment if the P discharge is above 0.075 mg P/L. After 20 years, if the TMDL is met with MMSD emissions in excess of the final 0.075 mg/L standard, the standard may be recalculated and increased. However, if the TMDL for Badfish Creek is not met, MMSD will be required to meet the 0.075 mg/L standard through brick and mortar solutions, water quality trading, or a combined approach.

F. Community Acceptance

i) Whether the strategic communication plan has been effective in reaching out to the community as a whole.
ii) Whether broad based community support exists for moving forward with a full-scale Adaptive Management project.
iii) Whether agricultural producers in the Yahara watershed support the Adaptive Management project.

Strategic Communication Plan

Assessment

In its current form, the Strategic Communication Plan is inconsistent. It clearly identifies target audiences. However, the goals, assessment criteria, and parties responsible for achieving those goals are explicitly defined in some sections (e.g., agencies) but poorly defined in others (e.g., agricultural producers and public). Such inconsistencies will make assessing communication effectiveness difficult.

Communication efforts of several MOU partners has been effective at garnering regional and national attention for the pilot project. However, awareness and support are not the same thing. The goals of reaching out to the community as a whole are currently not explicitly defined in the Strategic Communication Plan, making assessment difficult (also see Messaging below).

Recommendation

With the pilot project now underway, the Strategic Communication Plan should be reassessed and updated as necessary. Based on experience thus far, who are the target audiences? What has and has not worked in communicating with them? What is the desired outcome of communication, and who is responsible? Importantly, multiple sections of this report emphasize that participation by all agricultural producers in the watershed is not necessarily required to reach project goals. While meeting goals may not require all agricultural producers to implement BMPs, communication efforts should still seek broad-based support within this community. Such support will likely be important for motivating producers to implement BMPs where they are needed.

Messaging

Assessment

Communicating with municipal partners has been very successful to date, given nearly complete participation by these entities (see Section D). The message that Adaptive Management could represent the most cost-effective way to meet TMDL requirements was clearly communicated. Full-scale participation is likely if a good business case can be made.

Communication with agricultural producers and the public appears fragmented. Yahara WINs, Dane County, Yahara Pride and NGO partners have all engaged in communication efforts through formal and informal presentations, meetings, reports and newsletters. However, a clear and simple message does not always emerge from these efforts. Discussions with staff from both Dane County and MMSD identify a particular messaging challenge with respect to producers and the public: there are several programs related to water quality improvement and BMP implementation, leaving producers understandably confused about the relationships among these projects, and how the AMO offers anything new or different.

Recommendation

Communication with producers and the public should emphasize a clear, simple message. The message should highlight the novelty and uniqueness of the AMO. Examples of key points to emphasize might include: everyone is working to solve the problem, the cost effectiveness of the AMO compared to other strategies, and the emphasis on low-cost BMPs. Messaging should be developed in cooperation with the partners identified in the Strategic Communication Plan to ensure consistency of communication from all partners. Finally, communicating pilot project results will be crucial for generating support for full-scale implementation. However, efforts to generate support should not wait until the pilot project is complete.

G. Net Environmental Benefits

i) Whether the pilot project resulted in a net environmental benefit in the target watershed. Examples of factors that could be considered as part of a net environmental benefit evaluation include habitat improvement; reductions in phosphorus, nitrogen and TSS loads; and reduction in carbon footprint.

Models

Assessment

When transferring the responsibility for P reduction from point sources to nonpoint sources, a mechanism needs to be in place to ensure that nonpoint polluters achieve the desired level of reduction. Therefore, both the baseline P index (PI) and effects of newly implemented practices on PI must be quantified. Unfortunately, monitoring field-by-field P loads to streams would be impossible, so estimates of P reductions from models need to be used. SnapPlus is a field-based PI calculator used in the development of nutrient management plans (NMPs). It allows the user to input field characteristics (soil type, slope, crops, animal units, etc.) and transport characteristics (distance to stream, etc) to estimate how much P is delivered from the field. Importantly, it allows changes in cropping practices (rotation, tillage method, cover crops, manure spreading, filter strips) to be incorporated into PI estimates. Therefore, SnapPlus is suitable for estimating the amount of P load reduction expected for a change in practices for a specific field. SWAT, which was discussed in the Technical Feasibility section to evaluate the potential for P reductions, is a similar model that calculates P loads at the watershed and sub-watershed scale, but does not have the capability to calculate field PIs.

The best use of SnapPlus would incorporate identification of fields where P loads can be reduced most cost-effectively. This use would require 1) that data used to run SnapPlus are available for a substantial portion of farms in the watershed; 2) that current and new practices that may be implemented on each field are simulated to quantify potential P loss; and 3) that costs of these practices are known. The highest P loads (and the potential for cost-effective reduction) are likely concentrated on a small number of fields and compose a small area (as is the case for the Pheasant Branch watershed, Anderson 2009; and for Wisconsin in general, Diebel et al. 2008).

Recommendations

With baseline data (assuming "baseline" means PIs can be calculated) on 7200 of 11000 (65%) cropland acres, the project is on its way toward meeting the first requirement listed above. In Pheasant Branch, for reference, 25% of the cropland acreage contributes 53% of the load (Anderson 2009), which suggests that knowing P loads and potential P load reductions on 65% of the land is likely to identify a substantial portion of the main P sources. However, the second of the above requirements has not been met. Even if fields are ranked by P losses, the highest producers may not be the optimal sources for reduction, because smaller fields with high P/acre will be ranked low (Anderson 2009). Moreover, BMPs may not be equally effective on all fields (Veith et al. 2003) as operator costs, distances to the nearest stream, etc. will vary within the watershed. Since SnapPlus is easy to run for most BMPs once field data are obtained, we recommend simulating other BMPs on each field to identify not just where P losses come from, but how much they can be mitigated be each BMP. If costs of these BMPs are also known (the third requirement), then fields could be ranked by potential P reductions per dollar, and more optimal solutions could be reached (e.g., Srivastava et al. 2002, Veith et al. 2004, Maringanti et al. 2009). These optimization plans can reduce the overall costs to reach P reduction targets by up to 15% (Veith et al. 2004) relative to more uniform targeting of BMPs. In other words, this approach would allow the net environmental benefit to be maximized for a given level of investment.

In contrast to SnapPlus, SWAT only identifies sub-watersheds where P loads can be reduced the most, but does not identify which fields within those sub-watersheds can be used for P reductions. Thus we recommend continuing to use SnapPlus so that decisions about which fields are subjected to BMPs can be made optimally.

Although SnapPlus may be manageable at the pilot scale, it can be time consuming to enter field data by hand for each field. Therefore, we recommend looking into reprogramming the SnapPlus algorithms so that data for fields and simulations based on changing BMPs could be simulated automatically if the program is to expand to the entire Yahara watershed. Batch processing is possible with SnapPlus, but may not suitable for these purposes (Laura Good, *personal communication*).

Field measurements

Assessment

Edge-of-field and instream data are needed to assess whether BMP implementation results in a measurable change at the edge of field or in the stream. There are four USGS monitoring sites and seven Rock River Coalition (RRC) Citizen Monitoring sites in the pilot watershed. Monthly baseflow chemistry measurements are taken at all sites, and high frequency storm sampling (~110 samples/site/yr) is conducted at the USGS sites. Parameters measured include total suspended solids, suspended sediment, nitrate, ammonium, total nitrogen, orthophosphate and total phosphorus. These measurements paired with USGS stream discharge are appropriate and sufficient for establishing P load baselines and evaluating interannual variation.

We were not able to locate edge-of-field monitoring data associated with the pilot project. However, there are two edge-of-field stations in the pilot watershed as part of the Mississippi River BasinHealthy Watersheds Initiative. One site has a clear progression in practices that will allow assessment of their impacts, but the other does not. Strong monitoring is necessary to ensure that modeled reductions are representative of true reductions.

It is important to document baselines and changes to instream P because instream targets are the long-term legal criteria. However, many factors (e.g., climate, legacy P) will impact instream P, so detectable changes may not occur even if improvements are made. Water quality improvements are likely to lag behind BMPs due to P storage in soils, wetlands, floodplains and the stream channel (Hamilton 2012). Thus, success criteria based on instream conditions are likely to prove elusive in the early stages of the program. Therefore, the choice of modeled reductions as success criteria instead of instream measurements for the pilot project is appropriate for the project timescale.

Recommendations

Edge of field monitoring should be increased and specifically targeted to evaluate the P reduction practices implemented as part of the pilot project.

Phosphorus reductions

Assessment

Based on model outputs, P reduction projects in the pilot watershed reduced P losses by 3,436 lbs in 2008-2012 and ~2,800 lbs in 2013. These combined reductions exceed the targets for 2013, thus the project is on track to meet targets (Figure 2). However, the majority of these reductions occurred prior to the inception of the pilot project, thus it is not clear why they should be counted towards pilot project reductions. Notably, reductions in 2013 were below the annual target of 3,500 lbs. Additionally, these reductions are attributable to demonstration projects; at the full watershed scale, widespread adoption of practices outside of the demonstrations will be necessary to meet targets. The early stages of the project are necessarily dedicated to research and planning, but BMP implementation efforts will need to ramp up in 2014.

Recommendations

An increase in the rate of BMP implementation will be needed to achieve the goals for 2014 and 2015. New projects should target sites with the largest losses because P loading at the watershed scale is often driven by a few sites with very large P losses (Diebel et al. 2008). Targeting will be constrained by the participation of producers, but success will ultimately depend on the willingness of specific producers to participate in reductions.

Other environmental benefits

Assessment

In addition to P reductions, the pilot project has the potential to reduce N and sediment losses and improve wildlife habitat. Although nutrient management plans and implementation of other BMPs to reduce P are likely to yield other improvements, we were not able to locate any direct assessment of the benefits in these categories conferred by the pilot project.

Recommendations

If these criteria are important for success, more information should be collected on the benefits derived from pilot project activities.

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