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Nutrient management planners' feedback on New York and Pennsylvania phosphorus indices

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Abstract: State phosphorus indices (PIs) are being evaluated across the United States due to variability in phosphorus (P) management recommendations and questions about the lack of water quality improvement in some watersheds. Nutrient management planners in New York (NY) and Pennsylvania (PA) were surveyed via two separate "but related" questionnaires to document perspectives on the current NY-PI and PA-PI and to obtain recommendations for improvements. Many planners were content with the current versions of the PIs but felt improvements could be made to more strongly discourage application of manure under conditions of high P loss potential and better promote certain best management practices. The NY planners felt that the NY-PI should discourage manure application during winter and to fields near streams, and should more strongly promote manure incorporation or injection, establishment of cover crops, ground coverage with crop residues, and implementation of setbacks and vegetated buffers. Similarly, the PA planners felt that the PA-PI should more strongly discourage manure application to fields with insufficient ground cover, near subsurface drainage and surface inlets, and during winter. In addition, the PA planners said the PA-PI should more strongly encourage soil conservation practices such as no-till, use of cover crops, and vegetated buffers. Results of the survey suggest common experiences and viewpoints among planners in NY and PA, resulting in a valuable on-the-ground assessment of the PIs as a nutrient management planning tool in both states, and the potential for development of a single, physiographic region PI.

Key words: best management practices—manure—nutrient management planners—phosphorus index—survey

The phosphorus index (PI) is an assessment tool designed to estimate the relative risk of phosphorus (P) loss from agricultural fields and to motivate farmers to change management practices to reduce this risk (Lemunyon and Gilbert 1993). This tool has been integrated into the USDA Natural Resources Conservation Service (NRCS) 590 Nutrient Management Standard since 1999 (USDA NRCS 2011). Currently, 48 US states use a PI approach to P management (Sharpley et al. 2003). Each state modified the original formulation of the PI to address local conditions and priorities, resulting in variations in the PI among states (Sharpley et al. 2003; Osmond et al. 2006). In response to criticism that some states' PIs do not direct farmers to make significant changes in P management practices and the perceived lack of improvement in reduction of P loadings to many of the nation's surface waters since introduction of the PI in 1999, NRCS has required states to evaluate and, where needed, improve PIs across the United States to better reflect site vulnerability to offsite P loss (Sharpley et al. 2011, 2012, 2013).

The identification of management practices and field conditions that either have not been adequately built into current versions of the PIs, or were incorporated but do not contribute to changes in P management practices in fields with high risk of P loss, is critical for the evaluation of the PI. The PI should promote management practices that are effective in reducing P loss risk (desirable practices) while discouraging practices with a high risk of P loss (undesirable practices). In addition, because of the time and resources required to carry out nutrient management planning, a PI should not include assessment of factors that are (1) unimportant in determining relative risk of P loss, (2) difficult or impossible to determine with some level of accuracy by farmers or farm advisors, and/or (3) cannot be changed by implementation of alternative management practices.

Nutrient management planners play a key role in applying the PI and in making sure that it produces actionable recommendations for farmers. These planners have close knowledge of the farms with which they work; the diversity of management practices and opportunities that exist on these farms; and priority nutrient management concerns, including the causes of water quality violations associated with manure management. Because nutrient management planners are knowledgeable about farmer fields and will need to implement future versions of the PI, their feedback is key to ensuring that revisions are effective in identifying high risk situations and promote actionable outcomes.

As part of the demand by NRCS for states to address potential deficiencies in the PI, researchers and action agencies from the Chesapeake Bay watershed have been collaborating to systematically test existing PIs and consider coordinating revisions. One possible outcome is to develop PIs on a physiographic basis, or at least ensure that assessments and recommendations within a physiographic region are consistent across state lines. Four distinct regions were identified in the Chesapeake Bay watershed: Allegany Plateau, the Appalachian Valley and Ridge, the Appalachian Piedmont, and the Atlantic Coastal Plain regions (figure 1). New York (NY) and Pennsylvania (PA) are the principal states occupying the Allegheny Plateau region.

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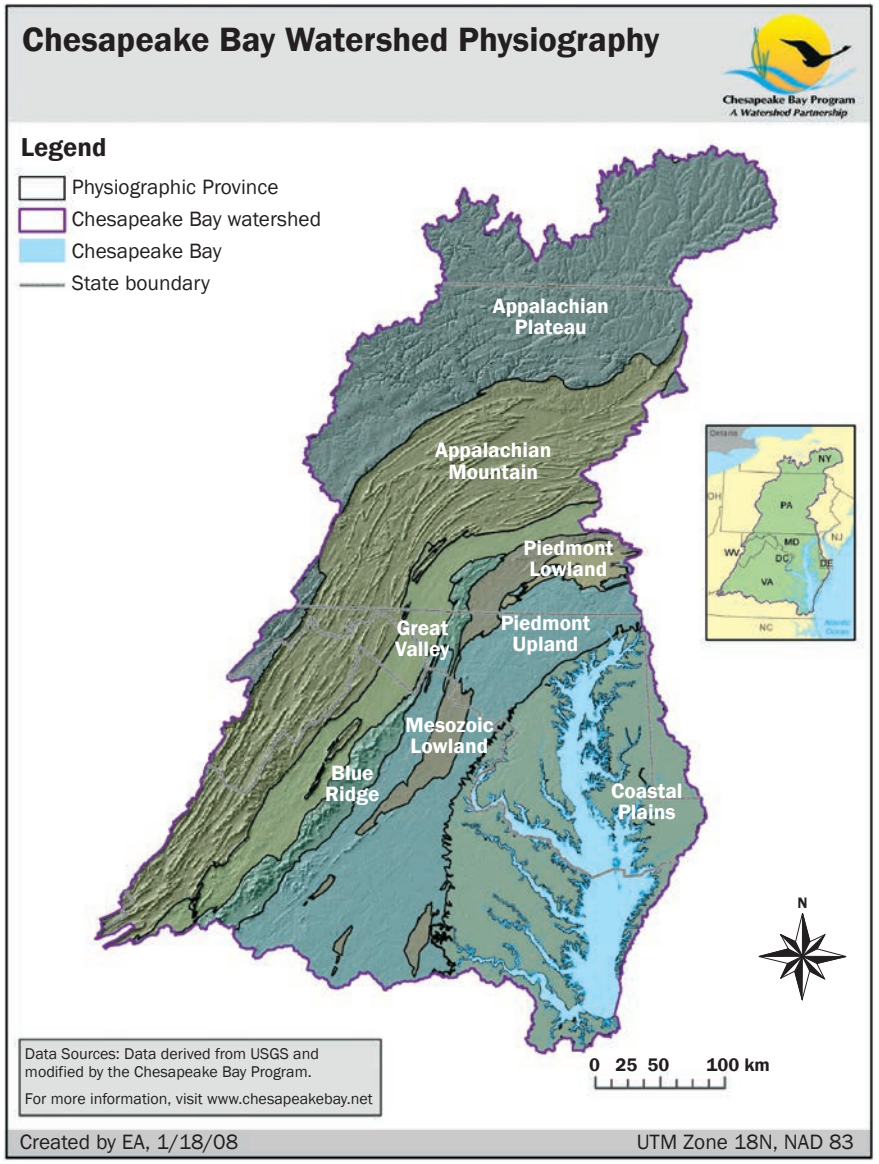
To aid in the assessment and possible revision of the NY- and PA-PIs, we sought to evaluate the perspectives of nutrient management planners in NY and PA. Specific objectives were to assess (1) which are the main drivers for water quality violations, (2) what is working well in each state's PIs, and (3) which changes should be considered in a revised version of the PIs to address high risk practices and encourage better management.

Structure of the Phosphorus Indices. The NY-PI assigns scores for dissolved and particulate P loss potential from a field (Czymmek et al. 2003). The *dissolved* NY-PI addresses the relative risk of loss of water-soluble P, while the *particulate* NY-PI estimates the relative risk of loss of P that is either attached to soil particles or a component of manure. The NY-PIs are separated into two main parts: source and transport scores, which are multiplied to obtain the final PI score. The same P source score is used for the dissolved and the particulate PIs and includes scores for soil test P, fertilizer rates, timing and method of application, and manure rates. The *dissolved* transport score is obtained by adding weighting factors for soil drainage, flooding frequency, and distance to stream via predominant flow paths (hereafter referred to as flow distance). The *particulate* P transport score is obtained by adding scores for soil erosion, flooding frequency, flow distance, and the presence or absence of concentrated flow patterns. Both transport scores are capped at 1, though depending on field attributes, the raw transport score may be greater than 1. When either the particulate or the dissolved NY-PI score equals or exceeds 100, no more manure or fertilizer P can be applied; applications up to annual P crop removal can be made when PI scores are between 75 and 99, while nitrogen (N)-based applications can be made when the PI score is less than 75. All fields on farms with a Concentrated Animal Feeding Operation (CAFO) Permit and farms seeking federal or state-cost sharing to construct best management practices (BMPs) are required to develop a certified nutrient management plan (CNMP), which includes running the NY-PI.

The PA-PI provides a single score only for P loss potential from agricultural fields (Weld et al. 2007). The PA-PI is divided into two parts, a screening tool (Part A) and a comprehensive field assessment tool (Part B). Part A evaluates a field based on watershed and management status, soil test P level, and contributing distance to a water body, and determines if a more detailed or Part B assessment is required. Part B of the PA-PI evaluates both source and transport factors in detail and calculates an overall PA-PI as 2 × source factor (soil test P rating + fertilizer rating + manure rating) × transport factor (transport sum × modified connectivity ÷ 24). The transport sum accounts for weighting factors associated with erosion, runoff potential, subsurface drainage, and distance to receiving water. The overall PA-PI score is then used to determine the nutrient management recommendation for a field. Low scores (0 to 59) and medium scores (60 to 79) receive a recommendation for N-based management. This means that nutrients can be applied to meet the N requirements of the crop. Nutrient application to fields with high PA-PI values (80 to 99) cannot exceed crop P removal, and no P can be applied to fields with a very high PA-PI score (100 and greater). All nutrient management plans developed under the Pennsylvania Act 38, CAFO, and USDA NRCS 590 programs are required to include PA-PI evaluations.

Figure 1
Physiographic regions of the Chesapeake Bay watershed (courtesy of the Chesapeake Bay Program Resource Library, http://www.chesapeakebay.net/maps/map/chesapeake_bay_watershed_physiography).



Planner Surveys. The NY survey contained questions related to (1) the main reasons for water-quality violations; (2) the relative importance of the source and transport factors in the current NY-PI; (3) management practices the NY-PI should encourage; (4) management practices the NY-PI should discourage; (5) changes that planners would like to see included in a revised NY-PI; (6) use of a screening tool to focus PI assessment on fields that are most likely to have a high risk of P loss; and (7) PI assessment across and within geographic regions (state-based, physiographic region-based, and watershed-based). The survey was emailed in the winter of 2013 to 2014 to 37 active nutrient management planners certified through the NY Agricultural Environmental Management program. Thirty-six certified nutrient management planners responded to the survey (97% response rate). The 36 planners included representatives from the private sector (consulting firms, 21 planners), Soil and Water Conservation Districts (12 planners), Cornell University Cooperative Extension (2 planners), and the NY Department of Agriculture and Markets (1 planner). Of the 36 planners, 11 had clients in the Upper Susquehanna watershed, headwaters of the Chesapeake Bay; 23 in central NY; 13 in western NY; 13 in northern NY; 12 in eastern NY; three in northern PA; and one in Long Island. The survey was deemed exempt from Institutional Review Board for Human Participants (IRB) review by the Cornell Institutional Review Board.

In PA, the survey was electronically distributed to the PA nutrient management community. The survey followed the general organization and question content of the NY survey. While the PA survey asked additional questions about the need to revise the PA-PI, the economic feasibility of recommended practices to reduce the risk of P loss, and planner's experience and background with nutrient management planning and the PA-PI, to maintain consistency with the NY survey, the responses to these questions are not summarized or included with this discussion. The distribution reached approximately 200 individuals, and 31 surveys were returned. Although the return rate is low (~15%), not all 200 individuals reached are certified nutrient management planners; many work in the PA Nutrient Management Program in a regulatory, policy, or educational role. Generally, a small percentage of commercial nutrient management planners are responsible for developing a majority of nutrient management plans in PA. It is estimated that the plans written by the certified nutrient management planners covers approximately one-half of the manure produced in the state. However, given that surveys were submitted anonymously, there is a need to assume that respondents are included in the group developing plans in PA. Of the 31 surveys received, 6 were from private planners and 25 were from individuals working in the public nutrient management sector. Of the private planners, 3 served clients throughout all of PA, 1 served clients in the Piedmont region, 1 served clients in the Ridge and Valley/Piedmont region, and 1 in the Allegheny Plateau and Piedmont regions. Of the public sector planners, 8 worked in the Piedmont region, 7 worked in the Allegheny Plateau region, 5 in the Ridge and Valley region, 2 worked in the Ridge and Valley and Piedmont region, 2 worked in the Allegheny Plateau, and 1 worked across PA. The survey was deemed exempt from IRB review by the Pennsylvania State University Institutional Review Board.

Planners rated the importance of the different factors of the NY-PI and the PA-PI with a score ranging from 0 to 10, with 1 to 3 being defined as irrelevant, 4 to 7 as somewhat critical, and 8 to 10 as very critical. Questions about the need for a screening tool, regions to which the PI should be applied, and need for a watershed-level PI, had predetermined options. Questions related to the drivers of water quality violations, practices the PI should encourage or discourage, and changes proposed in the revised PI were open-answer questions. Answers to these questions were grouped into categories created a posteriori based on the similarities of planner's answers. Results were expressed as percentages of the public sector planners, percentage of the private sector planners, and percentage of all planners that answered a given question.

Outcomes

Main Drivers of Water Quality Violations. In NY, more than half of the private sector planners (57%) and public sector planners (62%) indicated that water quality violations occurred even though the producer had followed the CNMP. In the NY planners' experience, water quality violations were typically driven by manure applications that took place (1) just before snowmelt or rainfall events (for both public and private planners), (2) on frozen, snow-covered, or saturated soils (especially for private planners), (3) too close to streams or ditches (particularly for public planners), and (4) without incorporation (mainly for private planners) (table 1). Some planners also identified not following the CNMP, human errors or mechanical failure, and unknown geology or the presence of karst soils as main reasons for water quality violations (table 1). Some of these violations could have been prevented if the PI and CNMP had been followed, but most violations reflected conditions that an annual planning tool such as the NY-PI cannot address. Recognizing that the PI is a planning tool that is part of a CNMP (annual planning cycles), additional guidelines were developed by Cornell University that help farmers answer the question "Is today is the right day to spread?" (Czymmek et al. 2005). It is, however, obvious from planner feedback that CNMPs cannot always be executed as written, as reflected in a response from one of the planners: "Freak and unusual weather makes planned outcome sometimes unachievable."

The PA planners indicated that manure application too close to streams or ditches, before a rainfall or snowmelt event, or to saturated or frozen soils, and not following the farm nutrient management plan as well as unknown geology or karst topography were the most common causes of water quality violations (table 1). Other reported but less common causes of water quality violations include lack of crop residue or ground cover. Water quality violations did not necessarily result from a lack of CNMP development and implementation. Water quality violations were reported to have occurred in situations in which farms had implemented nutrient management plans as well as for farms that did not have an implemented nutrient management plan. The relationship between CNMP implementation and water quality violations was variable, and a larger data set is needed to draw conclusions about the impact of nutrient management planning and implementation and the frequency and severity of water quality violations.

Importance of the Phosphorus Index Factors. In NY, each of the source and transport factors included in the current NY-PI were considered important by the nutrient management planners, although relative importance varied (table 2). Within the source factors, soil test P as well as manure applica-

Table 1
Top ten reasons for water-quality violations. Percentage of planners in New York and Pennsylvania.

	New York (% of planners)*			Pennsylvania (% of planners)		
Reasons	**Public sector**	**Private sector**	**All planners**	**Public sector**	**Private sector**	**All planners**
Manure application						
Before rainfall or snowmelt	77	67	72	6	67	23
To saturated or frozen soils	38	57	50	0	33	9
Close to stream ditches or wells†	46	29	33	50	33	45
Without incorporation	15	29	22	0	0	0
To fields without ground cover	0	10	6	6	0	5
Human error or mechanical failure	15	24	22	0	0	0
Unknown geology or karst soils	8	29	19	13	0	9
Not following the CNMP‡	46	33	39	13	0	9
Concentrated flow not identified	31	10	17	0	0	0
Flooding	0	10	6	0	0	0

*For New York, all planners include two planners that work for both private and public sector.
†For Pennsylvania, manure spread close to streams or ditches also includes wells.
‡Certified Nutrient Management Plan.

tion rate, timing, and method were rated as very critical factors for determining relative P loss potential, while fertilizer management practices were considered somewhat critical. Each of the transport factors were considered critical to P loss assessment as well, with a slightly higher importance score for flow distance to the stream. The scores given by private and public planners were similar (table 2). Planner quotes support the feedback that the current NY-PI has impacted nutrient management planning in NY in a positive, constructive way: "The P index should not be revised. I think it is working pretty well as is. I could see some fine-tuning or small enhancements, but not a complete revision." Another planner stated, "I believe the NY P Index has changed the way farms handle manure for the better, not been cumbersome to industry or the planning community and has been easy enough to implement."

In PA, based on an average of all responses, both private and public sector, all source factors in the current PA-PI were rated as either very critical or critical (table 2). Overall, soil test P and erosion were the most important PA-PI factors. The least important PI factors were fertilizer timing and fertilizer method of application. Differences existed between public sector and private sector responses. Public sector specialists gave higher ratings for soil test P, P application rate, and distance to stream than private sector planners, and the importance of P application timing was identified as less important than for private sector specialists (table 2).

Table 2
Relative importance given by New York and Pennsylvania nutrient management planners to the factors included in their state's phosphorus indices. Score: 1 to 3 (irrelevant), 4 to 7 (somewhat critical), and 8 to 10 (very critical).

	New York (% of planners)*			Pennsylvania (% of planners)		
Factors	**Public sector**	**Private Sector**	**All planners**	**Public sector**	**Private sector**	**All planners**
Soil test phosphorus	8.0	8.2	8.0	9.2	8.0	9.0
Fertilizer rate	6.2	6.1	6.1	8.2	6.3	7.7
Fertilizer timing	6.2	5.6	5.8	6.4	7.5	6.9
Fertilizer method	6.3	6.5	6.4	6.4	6.7	6.6
Manure rate	8.6	8.5	8.5	8.0	8.0	8.3
Manure timing	8.2	8.7	8.5	7.1	7.5	7.6
Manure method	8.4	8.6	8.5	6.8	6.8	6.9
Drainage class	6.8	6.9	6.9	NA	NA	NA
Flooding frequency	6.9	7.1	7.1	NA	NA	NA
Distance to a stream	8.8	8.4	8.5	9.0	7.8	8.6
Concentrated flow	7.6	7.0	7.3	NA	NA	NA
Erosion	7.2	7.3	7.4	8.5	8.2	9.0

*For New York, all planners include two planners that work for both private and public sector.

Management Practices that the Phosphorus Index Should Encourage. In NY, nutrient management planners suggested that the NY-PI should incentivize manure incorporation (58% of planners), implementation of cover crops (39%), establishment of setbacks and vegetated buffers (36%), preferential manure applications to fields without connectivity (28%), and implementation of practices to reduce erosion (22%) (table 3). Public and private sector planners both encouraged manure incorporation and cover crops, whereas setbacks and vegetated buffers tended to be preferred more by public planners than private sector planners (table 3).

Pennsylvania nutrient management planners most commonly responded that setbacks and vegetated buffers, practices to reduce erosion, and cover crops should be encouraged through the PA-PI (table 3). To a lesser extent, there was support for encouraging practices to improve infiltration, to lower manure application rates, to apply nutrients on fields with a low risk of runoff, and to incorporate manure. Both public sector and

Table 3
Top ten management practices that the New York and Pennsylvania phosphorus indices should encourage.

Factors	New York (% of planners)*			Pennsylvania (% of planners)		
	Public sector	Private sector	All planners	Public sector	Private sector	All planners
Manure application						
With incorporation/injection	62	62	58	0	16	3
To fields without connectivity	23	33	28	0	0	0
At lower rates	23	19	19	13	17	14
To fields with low loss risk	8	24	17	4	0	3
Practices to						
Reduce erosion	23	14	22	60	67	62
Improve infiltration	8	5	11	22	17	21
Cover crops	38	38	39	48	67	52
Setbacks and buffers	54	29	36	61	50	59
Subsurface drainage	0	10	8	0	0	0
Common sense with weather	0	24	14	0	0	0

*For New York, all planners include two planners that work for both private and public sector.

private sector planners were supportive of encouraging these practices (table 3).

Management Practices that the Phosphorus Index Should Discourage. Planners from both NY and PA supported discouraging manure applications to frozen, snow-covered, or saturated soils; to fields close to stream and ditches; to fields without ground cover; and to fields with steep slopes; as well as the use of high manure and fertilizer rates, with percentages depending on the state and the sector they work for (table 4). In addition, NY planners tended to discourage manure application without incorporation, while PA planners tended to discourage fall tillage. A large percentage of NY planners specifically mentioned "manure" rate, timing, or method of application in their responses, while a low percentage of NY planners specifically mentioned erosion control. For PA planners, this was reversed, reflecting a greater emphasis on erosion control. However, many NY planners encouraged practices like cover crops, which is reported separately as a recommended BMPs and an indirect way of reducing risk of erosion. In PA, public sector planners tended to show greater support for discouraging these practices than the private sector planners.

Changes that Planners Would Introduce in the Revised Phosphorus Index. Although nutrient management planners in NY considered all factors in the NY-PI to be important, 89% of the public planners and 60% of the private planners recommended to update the weighting factors for the individual components (table 5), particularly the weighting factor for the timing of manure application as illustrated by the following quote: "The current weighting of factors appears to be somewhat arbitrary. I think that research should be conducted to evaluate each factor and the weights adjusted accordingly. For example, how was it determined that a poorly drained soil is 10 times higher risk than a well-drained soil?" Examples offered by planners included (1) to more heavily penalize manure applications to frozen, snow-covered, or saturated ground; (2) to weight manure applications in late April less restrictively than they currently are; and (3) to use real weather data to fine-tune the timing of manure application. Support for these viewpoints included the following: "I feel we have to assign a higher risk value to potential runoff from fields when the ground is frozen. There have been too many instances of field runoff this winter from snow melt and light rainfall." Another said, "Open up some or all April as a safe time to spread. Current timing is not reflecting what I am seeing as reality that most years at least the last one-half of April is a safe time to spread."

Table 4
Top ten management practices that the New York and Pennsylvania phosphorus indices should discourage.

Factors	New York (% of planners)*			Pennsylvania (% of planners)		
	Public sector	Private sector	All planners	Public sector	Private sector	All planners
Manure application						
To frozen, snow-covered, saturated soils	69	57	61	0	20	4
To fields close to streams or ditches†	54	43	44	22	20	21
Without incorporation/injection	23	43	36	0	0	0
At high rates	38	14	22	9	0	7
To fields with steep slopes	8	29	19	4	0	4
To fields without ground cover	8	19	14	87	60	82
On a daily basis	0	14	8	0	0	0
Leave fields without ground cover in winter	0	29	17	4	0	4
Not follow practices to reduce erosion	8	10	11	4	0	4
Fall tillage	8	10	8	30	0	25

*For New York, all planners include two planners that work for both private and public sector.

†For Pennsylvania, manure close to streams includes sensitive areas and sinkholes, manure on fallow fields includes winter spreading, and fall tillage includes tillage in all seasons.

Table 5
Top ten changes to implement in the revised New York and Pennsylvania phosphorus indices.

	New York (% of planners)*			Pennsylvania (% of planners)†		
Factors	Public sector	Private sector	All planners	Public sector	Private sector	All planners
Change coefficients	89	60	65	0	0	0
Timing of application	56	25	32	0	0	0
Method of application	33	10	16	0	0	0
Flow distance	33	15	19	6	0	5
Erosion‡	22	15	16	6	67	14
Credit						
Cover crops, residues	11	25	23	33	67	38
Setbacks, buffers, diversions	11	20	16	0	33	5
Slope	0	20	13	0	0	0
Subsurface drainage	11	10	10	0	0	0
Common sense	0	24	14	0	0	0

*31 of 36 New York planners answered this question.

†For Pennsylvania, not all planners responded to this question. Changes were suggested that were specific to Pennsylvania phosphorus index development and therefore were not included.

‡For Pennsylvania, change erosion coefficient includes using annual erosion estimates.

The most far-reaching change suggested by planners was replacing the calendar year as a driver for PI weights by actual field conditions: "Do away with calendar year ranking (i.e., February to April). The way we have seen such severe weather and climate changes, manure spreading could be more risky spreading in a wet summer versus a warm or dry winter. Should encourage using a ranking system based more on high-risk conditions versus calendar year. Use the field assessment data to determine when the field is at a high risk situation for spreading. Identify these fields with setbacks for spreading in spring, summer, and fall." Another planner said, "(The PI) needs to be more dynamic. How often is 4/30 [April 30] different than 5/1 [May 1]? These two days are on opposite ends of the risk spectrum…A system that better calculates risk based on actual field conditions is the direction we should be moving." Such a change would imply that CNMPs no longer have a PI assessment, but that farmers have a farm-based tool to determine on a day-by-day basis if a specific day is a good day to spread manure on specific fields. The latter could be a (computerized) merger between a PI as a planning tool within an annual CNMP that sets application rate limits and adverse weather spreading guidelines in the form of a written set of guidelines or weather-based model.

Other changes proposed by NY planners (particularly in the private sector) include crediting cover crops, manure spreading setbacks, vegetative buffers, and diversions; and take into account slope, subsurface drainage, and "common sense" (table 5). Currently, these factors are not explicitly incorporated in the NY-PI, although some of them are used for determining erosion through version 2 of the revised universal soil loss equation (RUSLE2) (USDA ARS 2008). There was also recognition that setbacks or buffers might not always be effective and that addressing the points of connectivity is more important. Moreover, there was concern among planners about the shift from rotation-based tolerable loss estimates in RUSLE2 for determination of the particulate PI to an annual erosion loss estimate: "Remove buffer incentives. Runoff from fields is never sheet flow. (Incentivize) field draws—spreading setbacks during winter." Also, "A move to single year RUSLE values will eliminate a lot of hill grounds in NY currently used for row crops. This could have a tremendous impact on NY Agriculture."

In PA, most planners viewed the current PA-PI source and transport factors as critical or somewhat critical to PA-PI assessments (table 1). Despite this, respondents indicated that changes to the PA-PI should be considered: specifically, inclusion of more direct credits for cover crops and ground cover; adjustments and changes to the erosion coefficients; and, as indicated by private sector nutrient planners, credits for setback, vegetative buffers, and diversions (table 5). Examples of these changes included (1) credits in the PA-PI evaluation process for no-tillage practices, grass buffers, and planting of cover crops; (2) simplification of RUSLE2 by potentially introducing standardized soil loss values; and (3) more restrictive soil loss and ground cover requirements for fields with high soil test P.

Screening Tool. In NY, most of the public sector planners (62%) and private sector planners (67%) did not support including a screening tool to quickly identify fields of low P loss risk in the revised PI (table 6). Of those in favor of implementation of a screening tool, 62% said it should be based on the flow distance to the stream and soil test P levels, while 31% were in favor of having decisions based on sensitivity of the watershed to excess nutrients. The different points of view are summarized in the following planner's quote: "I think each field should have a PI, if it's low that documents a low risk practice and can give a complete picture of the risk of a whole farm CNMP." Another said, "As the whole point of this exercise is to keep P out of the water resources, then those instances where this is not likely to occur could easily be screened out saving planners lots of time in proving a negative. I suggest that this be accomplished by examining the transport factors. Examples could be no flooding potential, great distances to streams, and no karst features."

Of the private sector planners in PA, 83% supported the continued use of the screening tool versus 64% for public sector planners (table 6). This difference may reflect the original intent of the screening tool to reduce workload and time associated with PA-PI evaluations; private sector planners complete more CNMPs, and the reduced workload may benefit them more.

Geographic Regions. In NY, 47% of the planners supported a physiographic-based PI (NY plus northern PA) compared to 35% who preferred to continue with the NY-based PI and 17% who preferred other approaches (i.e., watershed-based PIs) (table 7). The support for a physiographic PI was higher among public sector planners (62%) than among private sector planners (38%). In addition, a vast majority of the private and public sector planners (76% and 77%, respectively) indicated that there should not be multiple PIs within NY.

In PA, most respondents favored the continued use of a state boundary to identify areas where PA-PI assessments can be applied, although many respondents also supported

Table 6
The need to implement a screening tool (in New York) or to keep a screening tool (in Pennsylvania) as part of the state's phosphorus index.

	New York (% of planners)*			Pennsylvania (% of planners)		
Need for a screening tool	Public sector	Private sector	All planners	Public sector	Private sector	All planners
No	62	67	64	36	17	32
Yes	38	33	36	64	83	68
If yes, based on						
Proximity to surface water	40	71	62	NA	NA	NA
Soil test phosphorus	40	71	62	NA	NA	NA
Special protection watershed	20	43	31	NA	NA	NA

*For New York, all planners include two planners that work for both private and public sector.

Table 7
Planner feedback on the question if phosphorus indices should be based on physiographic regions or continue to be based on state boundaries.

	New York (% of planners)*			Pennsylvania (% of planners)		
	Public sector	Private sector	All planners	Public sector	Private sector	All planners
Physiographic region	62	38	47	32	33	32
State boundary	31	43	36	36	50	39
Others	8	19	17	32	17	29

*For New York, total includes two planners that work for both private and public sector.

defining this area based on physiographic region (table 7). Of the private sector planners, 50% supported use of a state-specific PI versus 36% of the public sector planners. Support for the proposed physiographic region approach was split evenly between private and public sector planners (table 7).

Other Comments Made by Planners. Additional feedback from the NY planners reflected their concerns about a lack of systematic assessment of water quality and limited knowledge of the impact of specific field management practices on P loss risk. Some planners pointed out that a yearly management tool like the PI is insufficient to make good manure management decisions on a day-to-day basis and proposed to use real-time weather data to know when the right day to spread is and when to avoid spreading. Other planners suggested to calculate P loss risk based on actual field conditions rather than on a calendar day. Some planners had concerns about modeling approaches that predict P loss and identified the need for allowance of professional judgment. They also indicated a desire to expand PI use to all farms and to implement an incentive payment program for implementation of effective BMPs for farms of all sizes.

In PA, in addition to suggestions for changes to the PA-PI assessment process that were already presented, CNMP planners expressed the need for field tools and information to better evaluate field conditions required as input in the PA-PI, improved methods for communicating options provided by the PA-PI to famers, and better approaches and tools for documentation of implementation. These comments reflect the need to simplify data collection for PA-PI assessments and to enhance PA-PI managment recommendations so that they can be more clearly communicated with the farmer.

General Implications

Water quality violations occurred for varied reasons in both NY and PA, but the most common circumstances in both states included manure application too close to a stream, in winter, or right before a major rainfall event. Planners in both NY and PA were comfortable with the PI used in their state and agreed that the current factors included were somewhat critical or critical. However, planners also indicated that there is room for improvement in both PIs. Although some differences were identified (for example, ideas about the use of a screening tool differed between the states), based on planner responses for both states, revised indices should rank fields based on (1) the field's vulnerability to loss relating to high P transport risk scenarios such as winter (snow-covered and/or frozen ground) conditions; fields close to or directly connected to streams, ditches, and wells; and nutrient applications shortly before a major rainfall event; and (2) implementation of BMPs that can be effective in controlling nutrient and erosion losses. The BMPs to be incentivized included maintaining ground cover, using no tillage, seeding of cover crops during the nonproduction portion of the crop cycle, incorporation or injection of manure instead of surface application, and implementation of manure spreading setbacks and vegetative buffers. Planners of both states suggested to simplify RUSLE2 calculations. Planners differed in their assessment of the need of a screening tool and whether or not the PI should be based on geographic regions rather than state boundaries. However, the feedback of the planners in both states with regard to what a PI should encourage versus discourage is consistent and suggests that a geographic region-based PI for NY and PA might be feasible. The planners in NY clearly identified a dislike of having more than one PI in the state, so any changes will need to be applied statewide in NY. Planners' close knowledge of fields and farmers' management of those fields is very important when considering the implementation of a revised PI, and their suggestions for improvement should be listened to and further evaluated.

Summary and Conclusions

Many NY and PA planners concluded the NY- and PA-PI had served the purpose of creating awareness and incentivizing BMPs with the potential to reduce P loss. However, many felt improvements could be made to more strongly discourage application of manure under adverse P transport conditions and better promote certain BMPs. The NY planners felt that implementation of cover crops, ground coverage with crop residues, and use of manure spreading setbacks and buffers should be strongly promoted by the PI while manure applications in winter and/or applications close to streams should be discouraged. Similarly, the PA planners felt the PI should more strongly promote soil conservation practices such as no-till practices, use of cover crops between main crops,

and establishment of vegetated buffers. The PA planners also felt that manure application on ground without suitable ground cover, manure application near subsurface drainage and surface inlets, as well as winter manure application should be more strongly discouraged by the PI. Thus, the results of the survey suggest many common experiences and viewpoints among planners in both states, possibly allowing for development of a single, physiographic region PI for the Allegheny Plateau.

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