Effective use of the Minnesota Phosphorus Index

Use the MN PI in the context of other nutrient management and environmental planning concerns. Most ag sites are low. There are other important sources of phosphorus.

The potential for misuse is inherent to models.

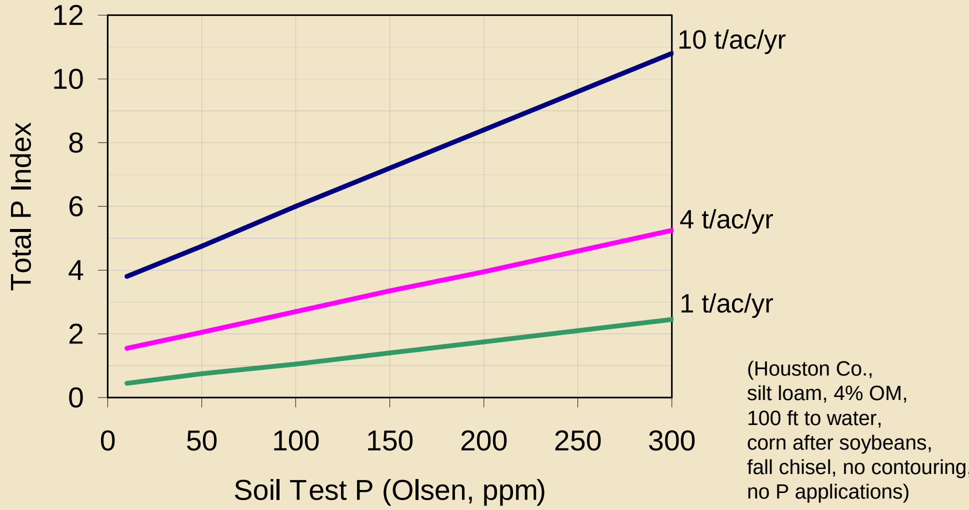
When we plug numbers into a program and get a number out, we are sometimes tempted to put more stock in the result than is appropriate. At the other extreme of reactions, some people reject a model completely after hearing about limitations, assumptions, etc. Avoid both of these reactions.

The only real numbers are runoff P measurements. That is impractical, so we take data from a long list of research and estimate risk of P runoff.

The way to prevent misuse is to understand the assumptions behind a model, what research it is based on, and under what conditions it works best.

Model Sensitivity:

Effect of Erosion and Soil Test P



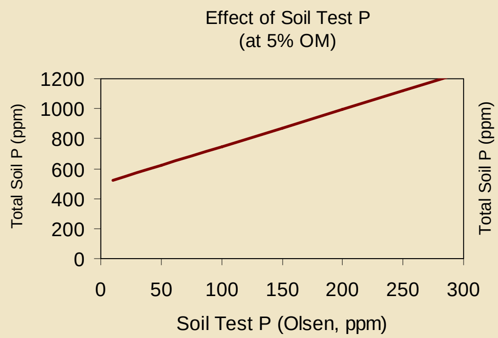
According to the model, what factors make the biggest difference in determining P loss risk?

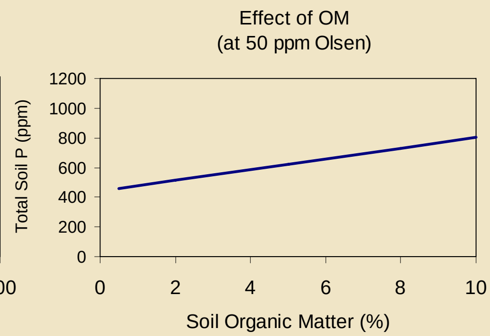
Compare doubling of STP to doubling erosion. Erosion has bigger effect.

Doubling the STP does not double PI result, because total soil P – not STP – is used to estimate risk.

Model Sensitivity:

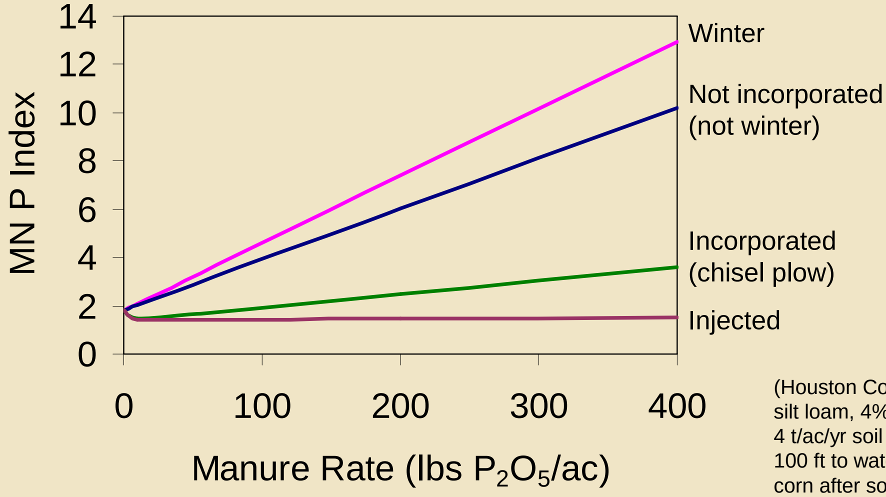
Estimated Total Soil P





Model Sensitivity:

Effect of Manure Rate and Application



(Houston Co.,
silt loam, 4% OM,
4 t/ac/yr soil loss,
100 ft to water,
corn after soybeans,
fall chisel, no contouring)

Model Inputs

- Good results depend on good inputs:
  - RUSLE2 sediment delivery
  - Distance to surface water
  - Alternative crops and tillage

Surface water definition: any water that is flowing most of the year. I.e., drainage ditches but not road ditches.

For alternative crops and tillage, use fall tillage that leaves similar roughness, use spring tillage that has similar effect on erosion, use crop that leaves comparable amount of fall residue.

Interpretations:

Results are not quantitative. Results correlate to loads, but do not tell you what loads are.

Actual delivery depends on intensity and timing of precipitation and antecedent conditions, which are difficult to model. Model components are based on different scales of research.

Not necessary to know actual load if you are trying to determine which site or practice is worth more attention, or how much a practice is worth relative to alternative practices or sites.

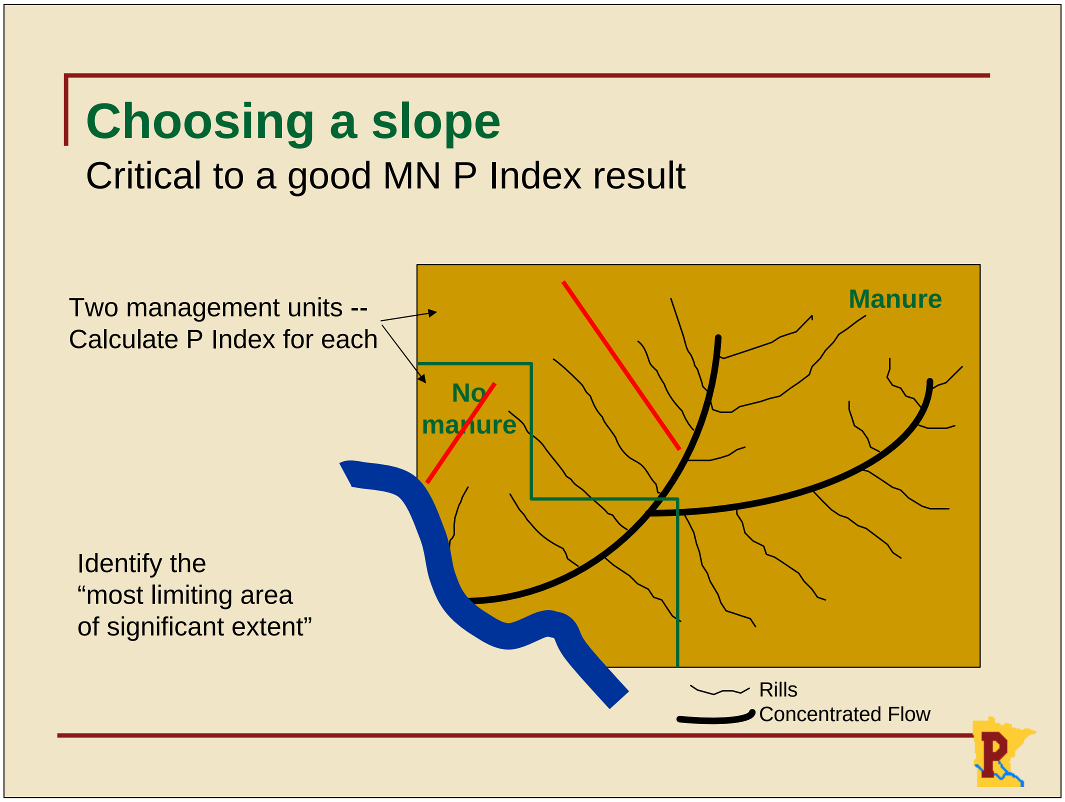
No consideration of receiving waters.

User can define low-med-high thresholds based on sensitivity of receiving water and P management objectives.

RUSLE2

- A model within the P Index model
- Estimates soil loss and sediment delivery to the edge of the field (or slope)
- Sheet and rill erosion only, not gully and wind erosion
- http://www.rusle2.org

RUSLE2 estimates sheet and rill erosion only. Gully and wind erosion are not considered in RUSLE2 or the P Index, but they may be an important source of phosphorus loss.



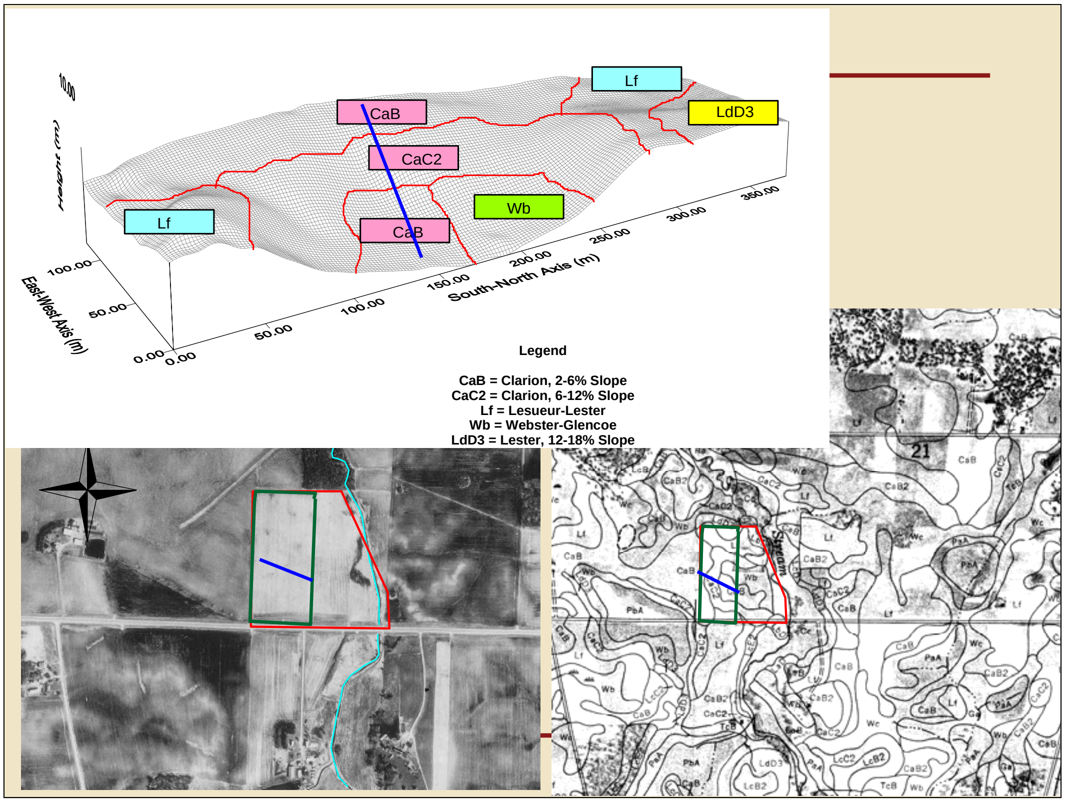
Major input into RUSLE2 is slope characteristics.

Erosion and P loss varies tremendously across a field, so focus on treating the critical source areas, or what the NRCS calls the "most limiting area" -- area with biggest erosion problems that limits the kind of management that will be used. (If you manage the area differently, then it is a different management unit with a separate RUSLE2 and MNPI calculation.)

Do not use an average slope. Don't use average slopes. Need to describe the part of the field where most of the sediment and P is coming from.

According to NRCS guidelines (Minnesota NRCS, 2004), choose the slope that represents the "most limiting area of significant extent." "Most limiting area" means the slope with the greatest risk of erosion, or in this case, P loss. Generally, this is the steepest slope in the field, but it may be the longest slope or the slope with extremely high manure applications (if erosion is being calculated for the P Index). "Of significant extent" means that the "most limiting area" selected should represent the characteristics of at least 20% of the field.

A second example of choosing a slope. End the slope at the edge of the field or where concentrated flow begins.



Another example of choosing a slope.

•Choose the “most limiting area of significant extent”

•Define beginning and end of slope: Begin slope at the origin of overland flow.

•End at the field edge or start of concentrated flow.

•Complex slope

•Determine slope length and gradient.

•(Or choose representative length and gradient from eFOTG. See help topic “Choosing a Slope”)

Gradient affects sediment delivery more than length. So generally choose the maximum gradient in the field.

Soil Loss vs. Sediment Delivery

Soil Loss	Sediment Delivery
For Conservation Planning by NRCS	For MN Phosphorus Index
Soil movement within the field	Soil that leaves the field (soil movement – deposition)
On-site soil degradation	Off-site damage
Use simple slope	Use complex slope

Understand the difference between soil loss and sediment delivery – two different estimates of sheet and rill erosion provided by RUSLE2.

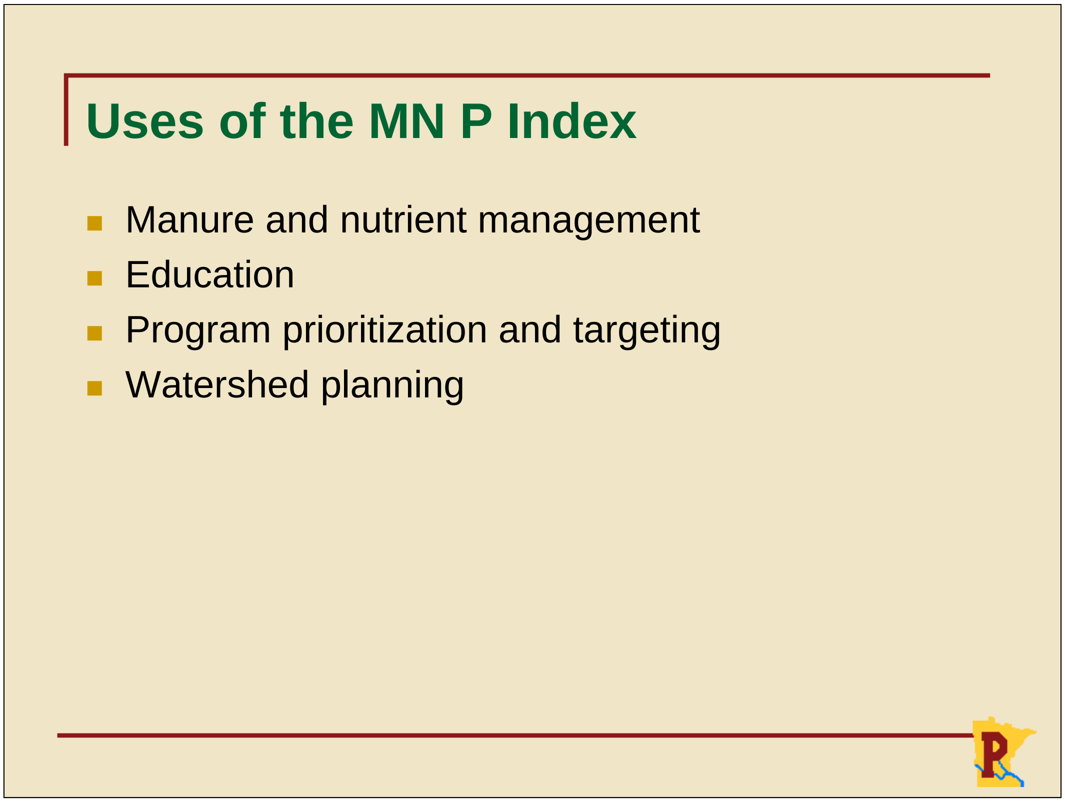
RUSLE2 is used differently to calculate sediment delivery than for the more common task of calculating soil loss for conservation planning. RUSLE2 soil loss is an estimate of sediment movement within a field. It primarily indicates on-site soil degradation. RUSLE2 sediment delivery is an estimate of the amount of sediment leaving a field. It primarily indicates off-site damage. Sediment delivery is generally less than soil loss because it includes more soil deposition than is included in a soil loss estimate.

Soil loss: There can be soil movement and degradation within the field, but not much soil leaving the field. Therefore, low sediment delivery does not mean low degradation.

To summarize the difference for using RUSLE2:

To get a good estimate of soil loss -- avoid including any deposition (e.g. toe slopes, filter strips).

To get a good estimate of sediment delivery -- include all opportunities for deposition.



Where to apply:

•Use screening tool to identify high risk sites.

•Use NRCS and feedlot rules to identify sites where further analysis is warranted.

•Examine a range of representative scenarios.

Relation to other tools.

•Use along with other nutrient and pollutant analyses.

•Only applies to ag, so may need to first assess relative contribution of point-sources vs. ag vs. streambank. Then use MNPI to assess ag.

Manure management:

•Use P Index to identify environmentally sound ways to apply manure.

•(Use in conjunction with other considerations such as N management, pathogen concerns, soil loss, etc.)

•Defer to NRCS and PCA discussions.

•Apply P Index on subfields. May allow manure application on a subfield, whereas you would be barred from application on the whole field if you calculate only one P Index.

Education

•Generate graphs illustrating the effect of alternative management practices, or showing how long it takes to draw down soil test P, or illustrating P sources and transport factors, or show interaction of multiple factors.

- •demonstrate effect of management alternatives
- •explain P sources and transport
- •address effect of multiple factors at once. E.g., demonstrate effect of no-fall

Watershed planning

Field-based P loss risk

1) Calculate P loss risk for fields across the watershed.
2) What proportion of sites are at high risk?
3) What if proposed BMPs were adopted on the high risk sites? Would the number of high risk sites decline?

P loss sensitivity assessment

1) Define range of landscapes and cropping systems in the watershed.
2) Run P Index on mock scenarios that represent that range.
3) Examine high risk scenarios. What factors (or combinations) are most important?
4) Target data collection, monitoring, cost share, and education to the appropriate sites and practices.

Before using the P Index, planners must determine that agriculture is an important source of P to the stream or lake. I.e., first account for urban runoff, municipal or industrial waste, ISTSs, streambank erosion, etc. Once ag runoff is identified as a P source, then the P Index can help pin-point and address the problem.

Method 1: Field-based P loss risk assessment

In small watershed, calculate P Index for most fields.

Focus on high risk sites. (Define "high" risk for your own purposes.)

Run "what if" scenarios, applying whatever BMPs or guidelines you are considering. Assess the effect of BMPs on the number of high risk sites.

Do not examine average P Index scores for the watershed. Most sites will probably be low risk, and 80%-90% of P is probably coming from a small proportion of sites. It may not be much help to reduce P loss from low risk sites.

Instead, monitor the number of sites that are high or medium risk.

(Birr's example on next slide.)

Method 2: P loss sensitivity assessment

In many watersheds, it is not feasible to run the P Index on all the sites.

Instead, use the P Index to ask, "In this watershed, what is P loss risk sensitive to?"

For each P Index input, make a list of the variations in your watershed. E.g., perhaps there are two or three major types of soils and landscapes, a couple crop rotations, a couple major types of tillage systems, and a couple of manure and fertilizer systems. Create a set of mock scenarios that represent the range of practices in the watershed. Run the P Index on these scenarios.

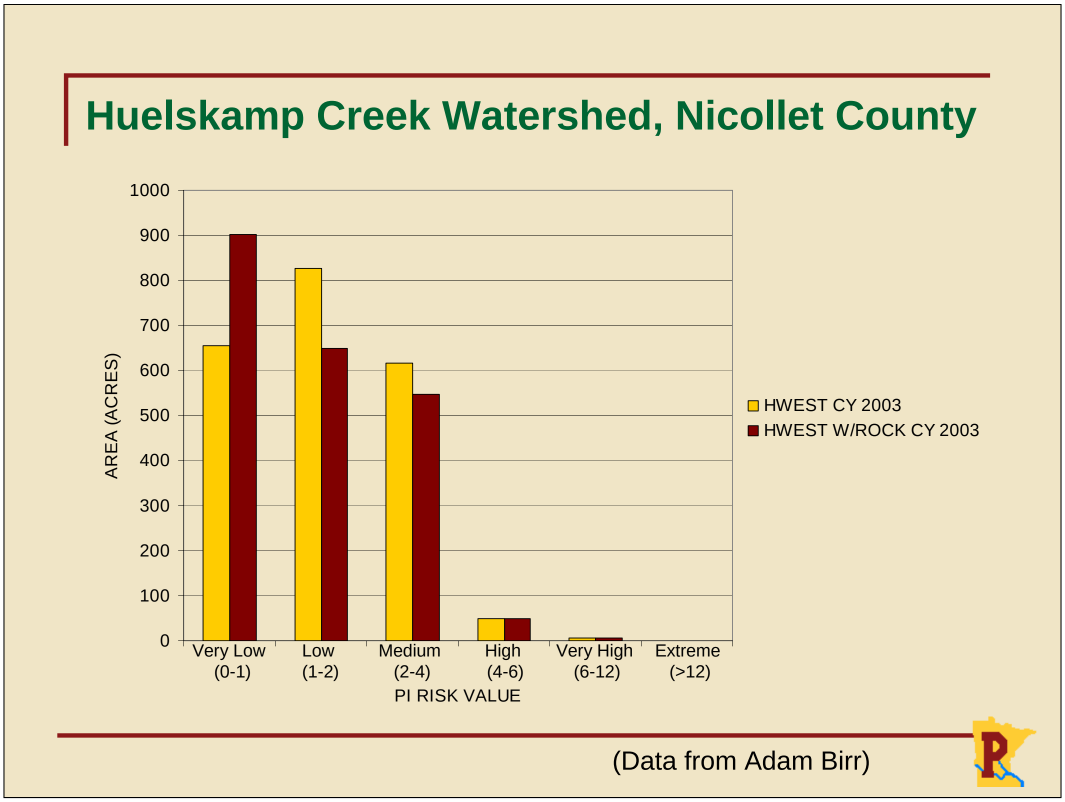
Examine results by using the "export scenario data" function in the File menu. Sort results by total P Index. Which scenarios have the highest P Index?

Narrow down the risk factors – e.g., perhaps moderate manure applications are not a big problem except on a particular poorly drained soil, and one common tillage system is a risk factor because it causes high erosion. Then, you can go out and collect data on those 2 or 3 factors, instead of collecting all the data necessary to run the P Index for every site. You can map and monitor changes in those 2 or 3 factors, focusing on appropriate BMPs and sites.

We did this (casually) near Duluth and found that because of the higher snow fall, snowmelt losses were extremely high and P loss risk was largely driven by winter manure applications. In a watershed in SW Minnesota, snowmelt is a much smaller issue and so winter manure application won't be as high on the list of factors driving P loss risk.

We know risk factors for P loss: surface manure application, low infiltration/high runoff soils, erosion, lack of winter roughness. . .

The benefit of the P Index is to examine how they interact.



Example of first approach: Field-based analysis of P loss risk in a watershed.

Watershed is about 4400 acres.

Note distribution of low-med-high risk sites for HWEST CY 2003,

compared to replacing surface inlets with rock inlets (HWEST W/ROCK CY 2003).

Rock inlets have no effect on the high risk sites. (Perhaps those sites didn't have surface inlets, or risk was dominated by surface manure applications.)

This is not to say that replacing open inlets with rock inlets isn't an effective BMP. But at this specific site, promoting rock inlets broadly would not address a significant amount of P loss risk.