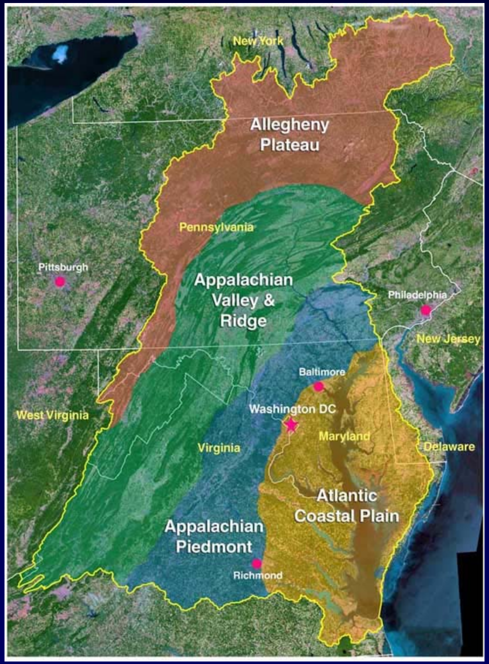
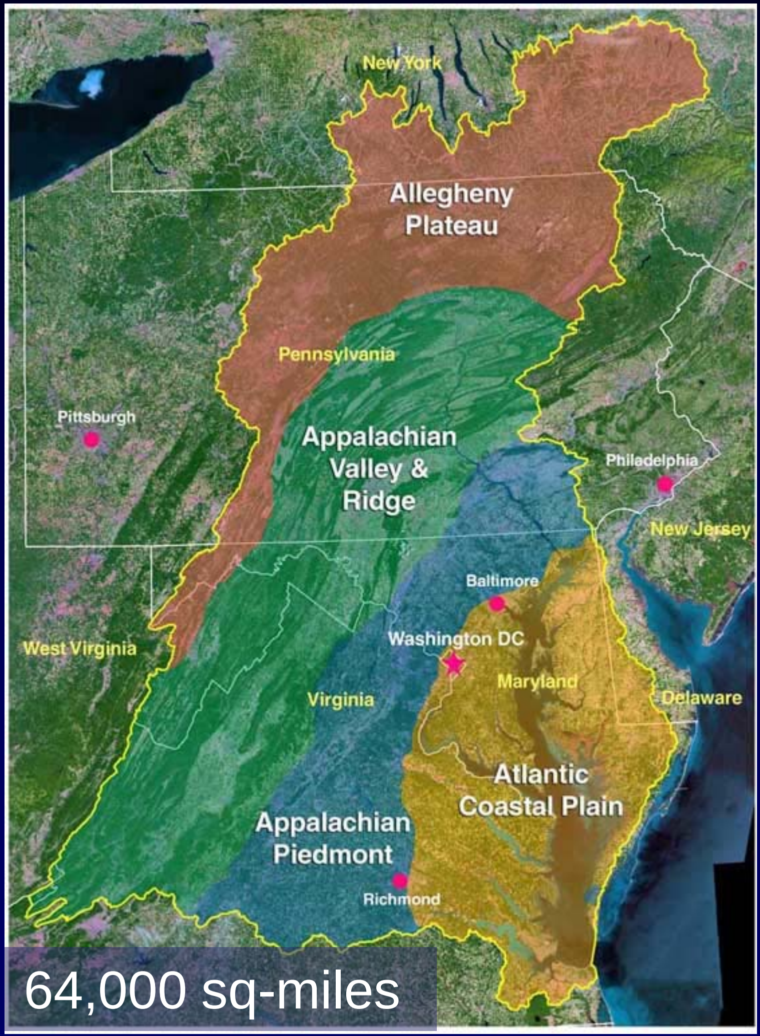
Phosphorus Management in the Chesapeake Bay Watershed

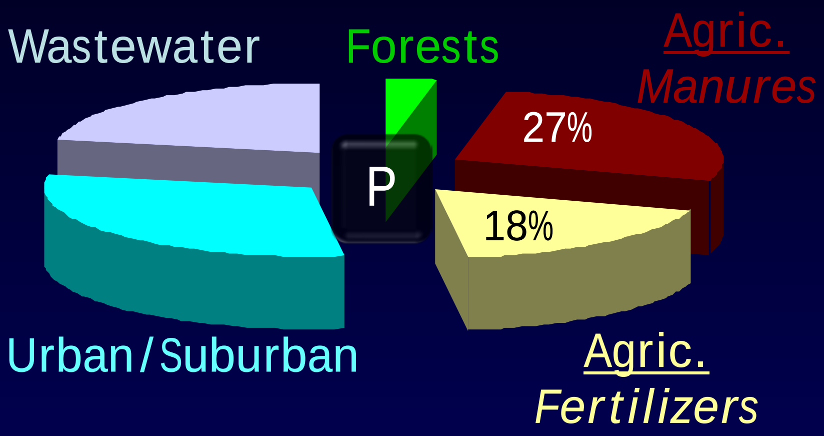


Pete Kleinman

USDA-ARS
University Park, PA

2009 Executive Order 13508
2011 Chesapeake Bay TMDL





TMDL goal – 15 million lbs P/yr

92 TMDLs

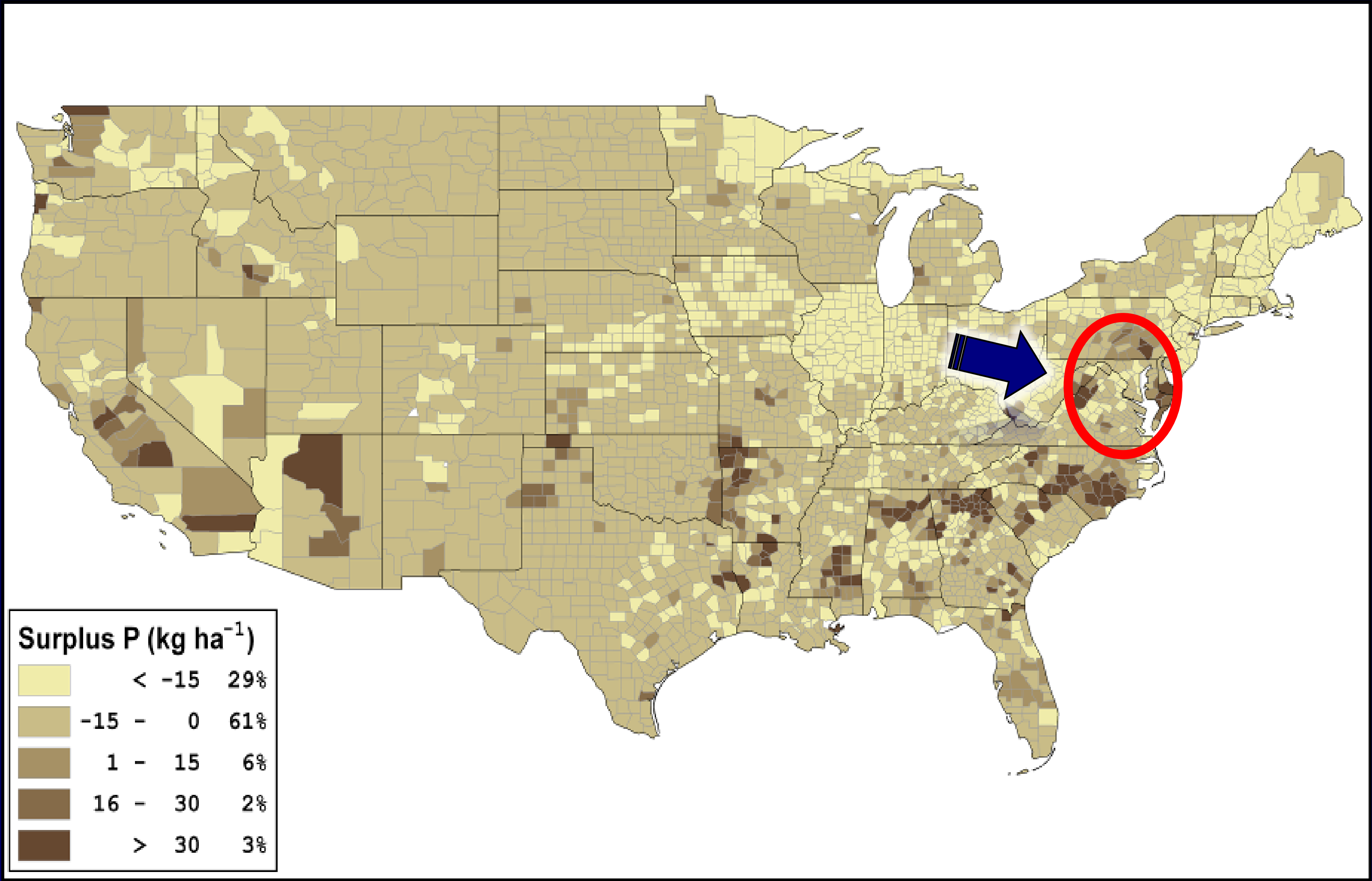
44,000 farms

17 million people

483 treatment plants

$2.36 billion federal funds to 2011

Long term causes
Regional nutrient imbalance



Courtesy R. Maguire, Virginia Tech

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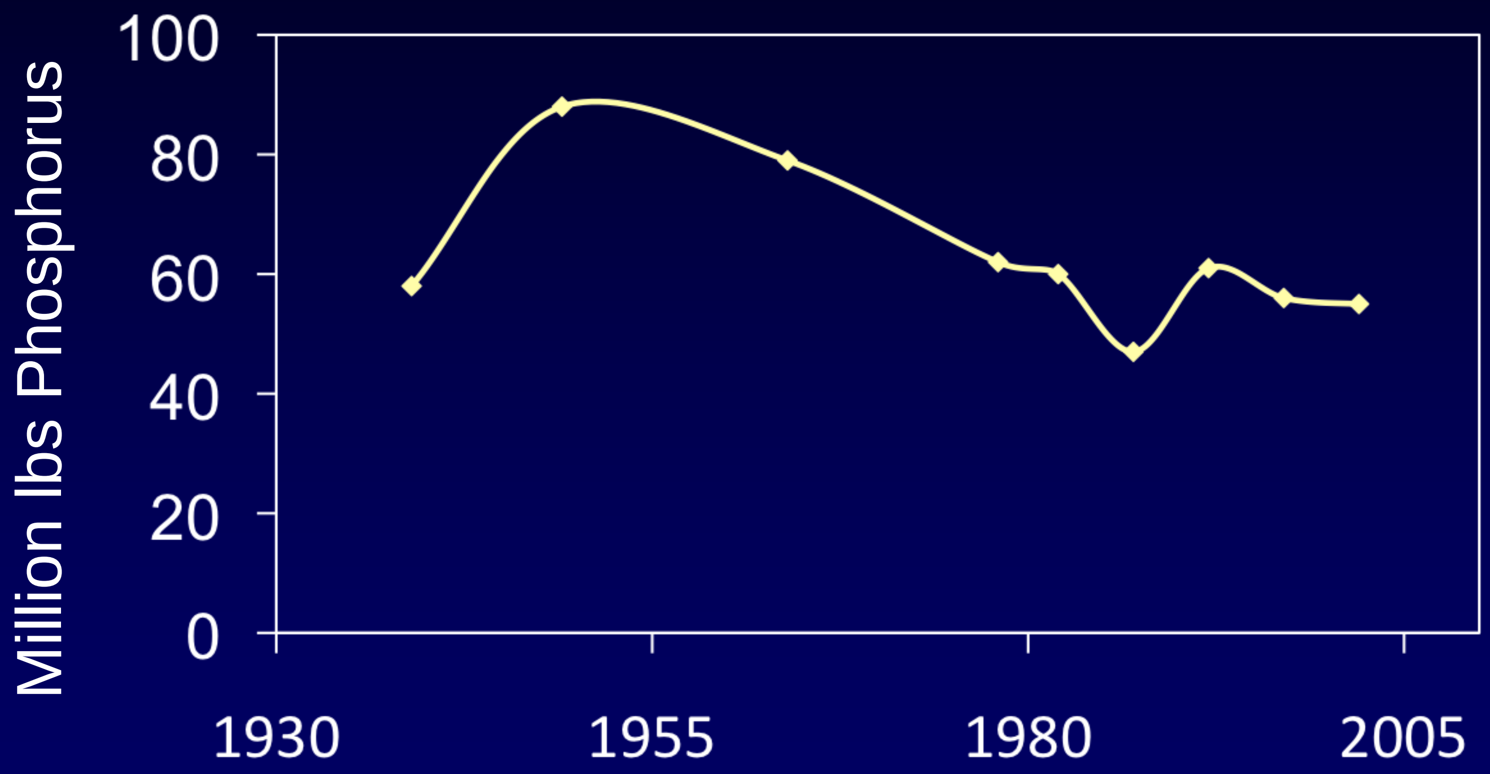
Pennsylvania cropland P balance
1939-2002



Courtesy D. Beegle, Penn State

The Beaver Stadium
108,000 Nittany Lion fans

100,000,000 gallons = 378,000,000 liters

Chesapeake Bay Watershed - Annual “waste” production

37 million lbs P/yr are applied in excess of crop requirement in 11 Chesapeake Watershed counties with highest animal densities

Livestock
(1.7 million au)
44 million tons manure

100 Beaver sta

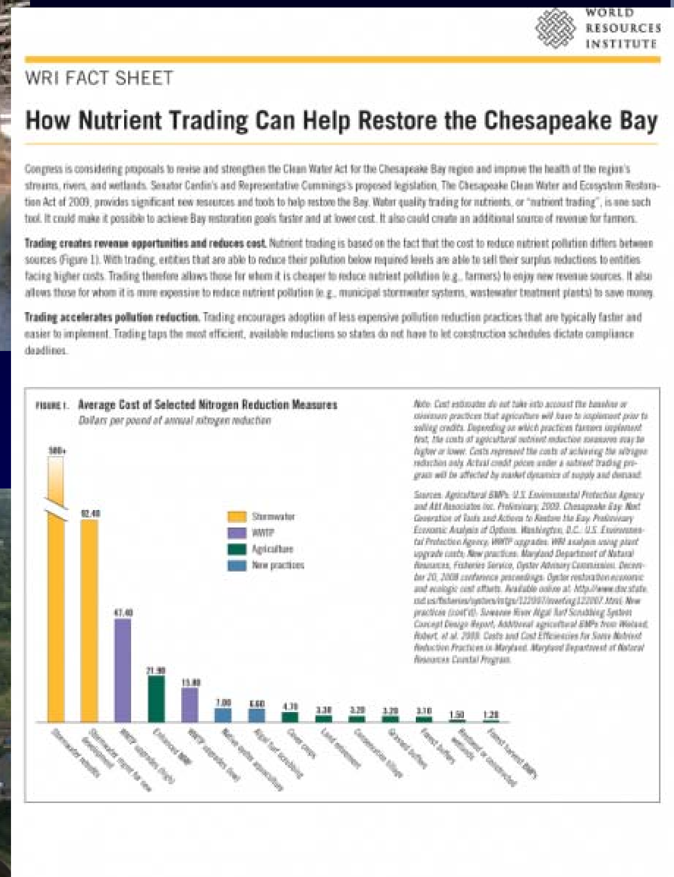
14 million humans
4 million tons

10

Manure export = P export

Delmarva litter pelletizing plant

Minnesota turkey litter power plant



WORLD RESOURCES INSTITUTE

WRI FACT SHEET

How Nutrient Trading Can Help Restore the Chesapeake Bay

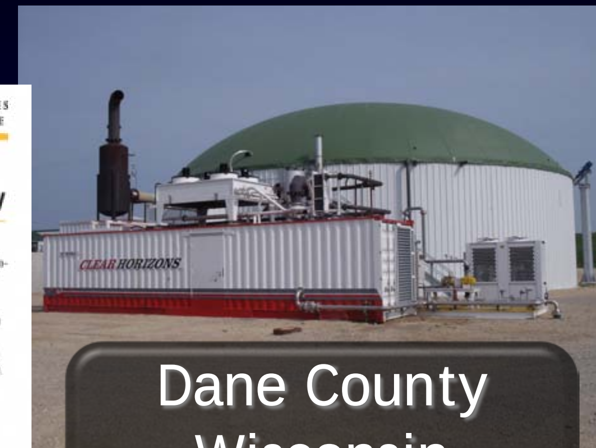
Congress is considering proposals to revise and strengthen the Clean Water Act for the Chesapeake Bay region and improve the health of the region's streams, rivers, and wetlands. Senator Cardin's and Representative Cummings's proposed legislation, The Chesapeake Clean Water and Ecosystem Restoration Act of 2009, provides significant new resources and tools to help restore the Bay. Water quality trading for nutrients, or "nutrient trading", is one such tool. It could make it possible to achieve Bay restoration goals faster and at lower cost. It also could create an additional source of revenue for farmers.

Trading creates revenue opportunities and reduces cost. Nutrient trading is based on the fact that the cost to reduce nutrient pollution differs between sources (Figure 1). With trading, entities that are able to reduce their pollution below required levels are able to sell their surplus reductions to entities facing higher costs. Trading therefore allows those for whom it is cheaper to reduce nutrient pollution (e.g., farmers) to enjoy new revenue sources. It also allows those for whom it is more expensive to reduce nutrient pollution (e.g., municipal stormwater systems, wastewater treatment plants) to save money.

Trading accelerates pollution reduction. Trading encourages adoption of less expensive pollution reduction practices that are typically faster and easier to implement. Trading taps the most efficient, available reductions so states do not have to let construction schedules dictate compliance deadlines.

FIGURE 1. **Average Cost of Selected Nitrogen Reduction Measures**
Dollars per pound of annual nitrogen reduction

Note: Cost estimates do not take into account the baseline or minimum practices that agriculture will have to implement prior to selling credits. Depending on which practices farmers implement first, the costs of agricultural nutrient reduction measures may be higher or lower. Costs represent the costs of achieving the nitrogen reduction only. Actual credit prices under a nutrient trading program will be affected by market dynamics of supply and demand.



Dane County Wisconsin manure digester

Arkansas poultry litter baling

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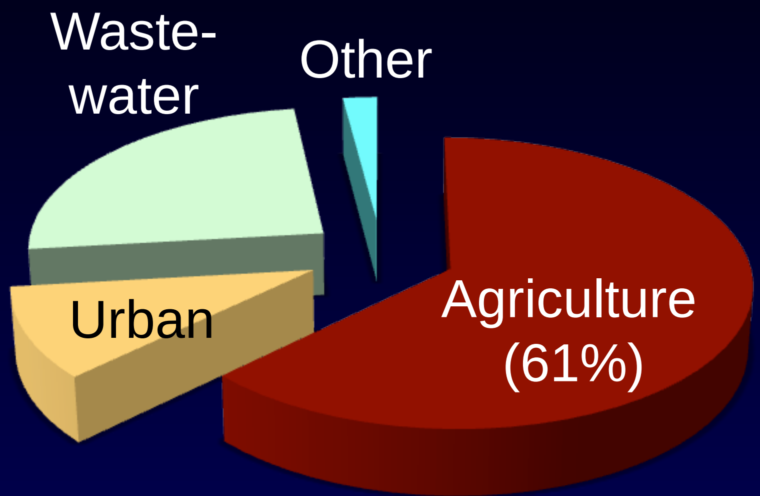
Benefit - agricultural BMPs

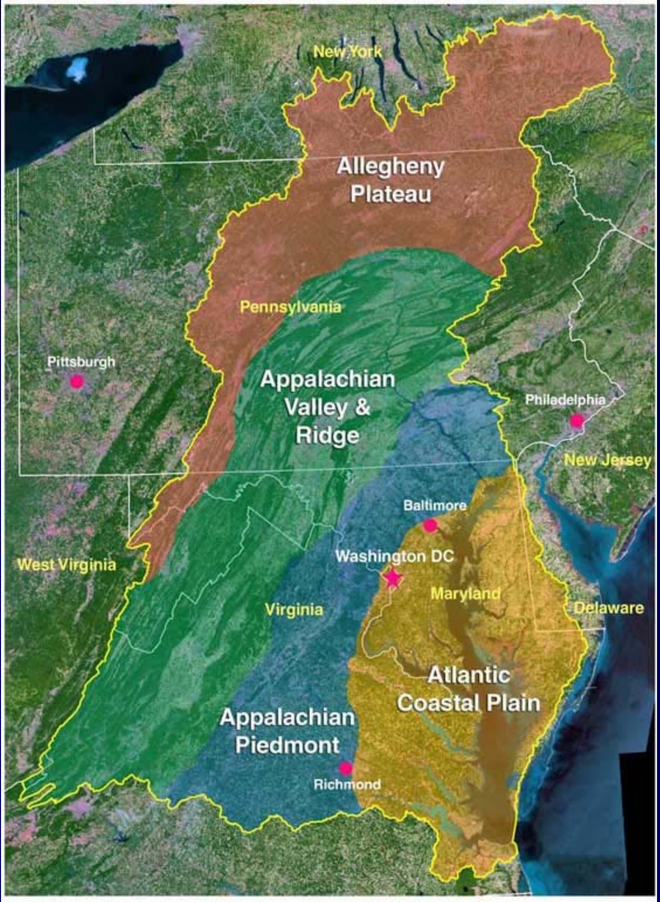


Expected P reductions

Next gen.

Casualty – Nutrient Management Planning

Chesapeake Bay Guidance for Federal Land Management



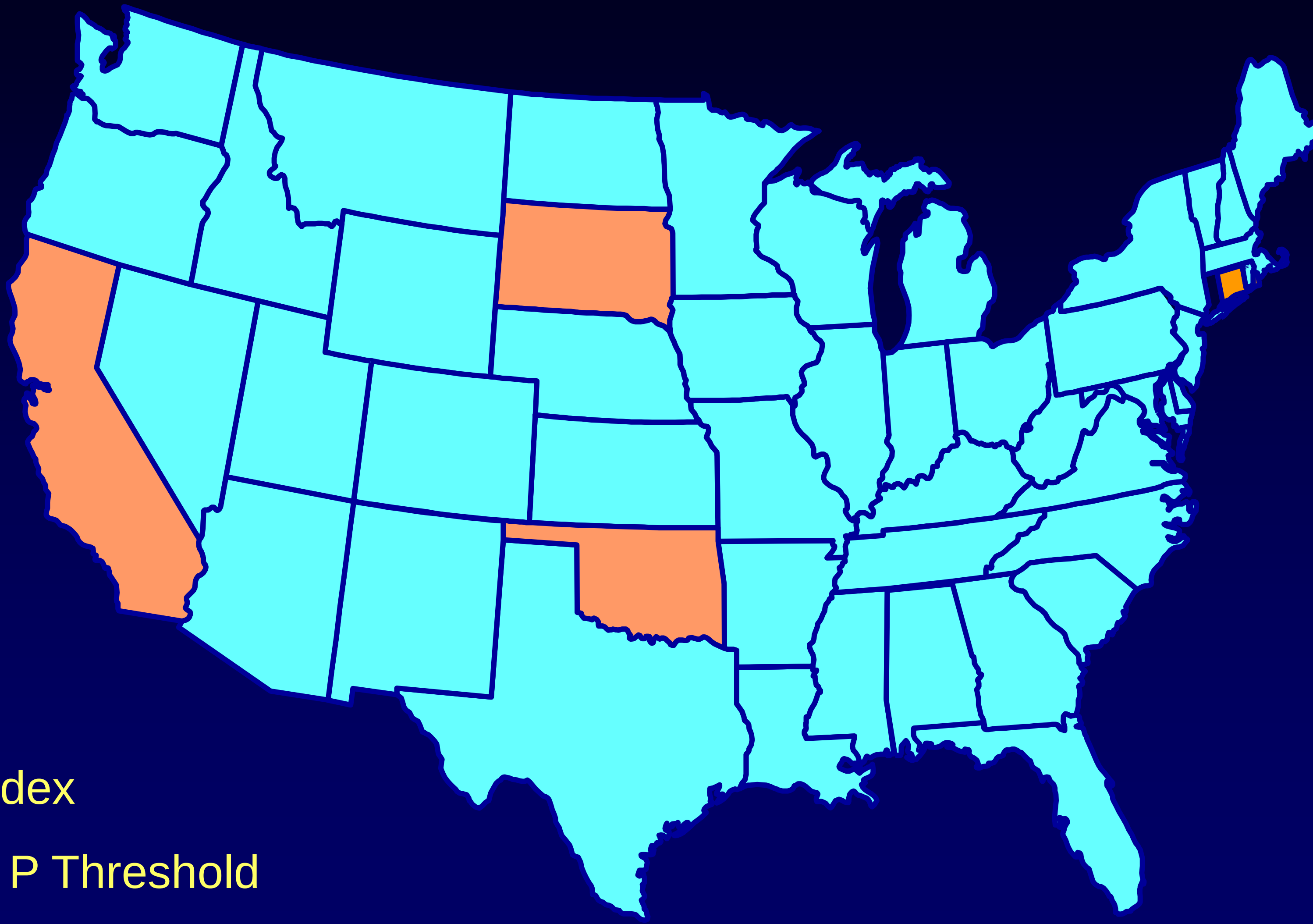
1. Replace P Index with soil environmental threshold (soil P saturation)
   - > 20% Psat, no added P
   - <20% Psat, up to N-basis
   - If Psat ⬆, P-basis

2. Need other tools to deal with hydrology, including re-implementing P Index.

Nutrient Management Planning – 1999 NRCS Uniform Strategy
Field Management of P

1. Soil threshold – agronomic
2. Soil threshold – environmental
3. Site assessment tool – P Index

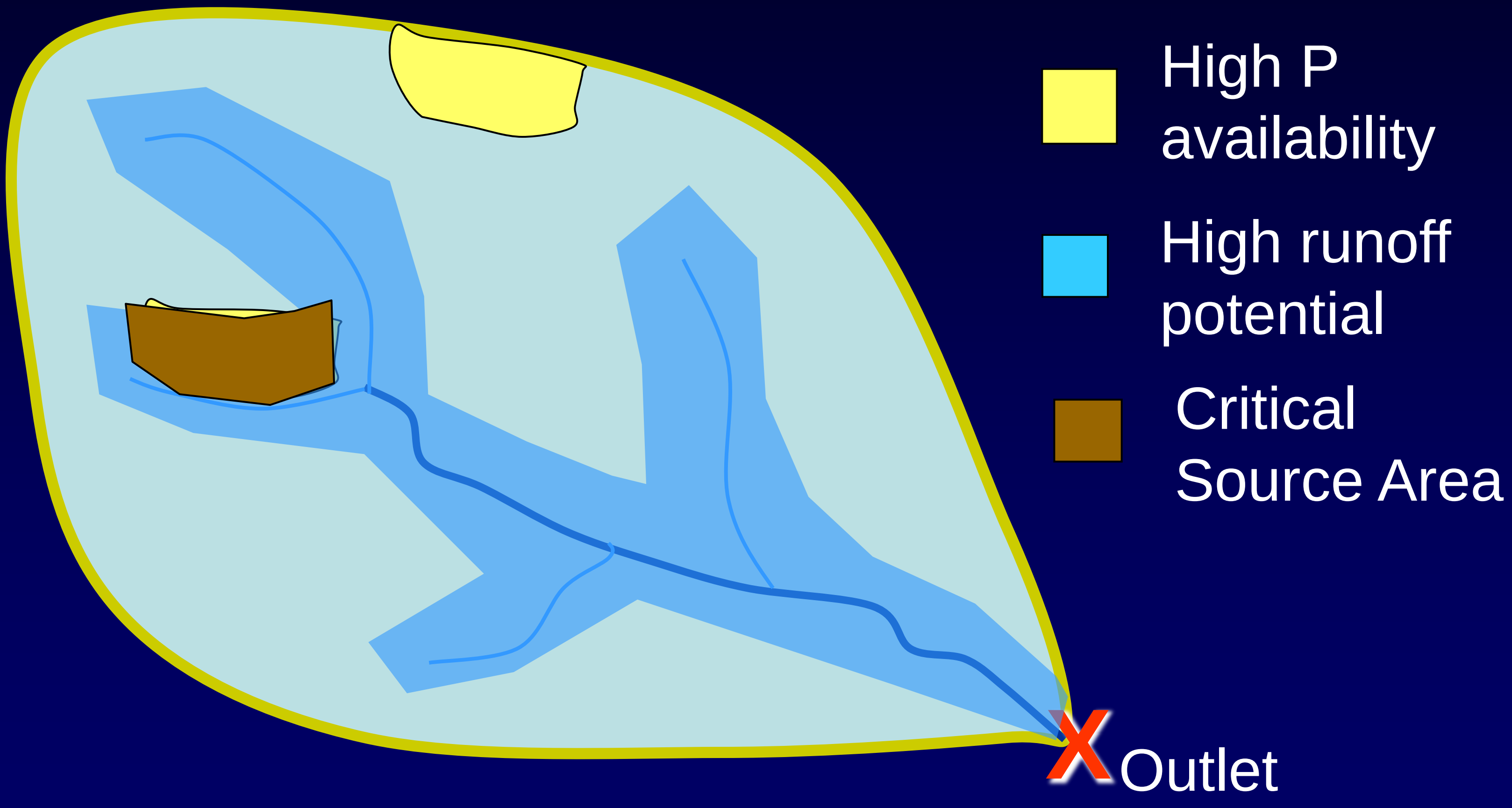
Field P management in the USA



P Index

Soil P Threshold

P Index – Identifies Critical Source Areas



P Index – Identifies Critical Source Areas

The Pennsylvania Phosphorus Index

Version 2

PART A: Screening Tool

		CMU/Field ID			
Is the CMU/field in a special protection watershed?	If the answer is yes to any of these questions, Part B must be used.				
Is there a significant farm management change as defined by Act 38?					
Is the soil test Mehlich 3 P greater than 200 ppm P? (Enter soil test value in ppm P)					
Is the contributing distance from this CMU/field to receiving water less than 150 feet?					

PART B: Source Factors

					CMU/Field ID				
Soil Test	Mehlich 3 Soil Test P (ppm P)								
Soil Test Rating = 0.20* Mehlich 3 Soil Test P (ppm P)									
Fertilizer P Rate	Fertilizer P (lb P_2O_5/acre)								
Fertilizer Application Method	0.2 Placed or injected 2 inches or deeper (e.g., starter fertilizer)	0.4 Incorporated less than 1 week following application	0.6 Incorporated more than 1 week or not incorporated following application in April to October	0.8 Incorporated more than 1 week or not incorporated following application in November to March	1.0 Surface applied to frozen or snow-covered soil				
Fertilizer Rating = Fertilizer Rate x Fertilizer Application Method									
Manure P Rate	Manure P (lb P_2O_5/acre)								
Manure Application Method	0.2 Placed or injected 2 inches or more deep	0.4 Incorporated less than 1 week following application	0.6 Incorporated more than 1 week or not incorporated following application in April to October	0.8 Incorporated more than 1 week or not incorporated following application in November to March	1.0 Surface applied to frozen or snow-covered soil				
P Source Coefficient	Refer to: Test results for P Source Coefficient OR Book values from P Index Fact Sheet, Table 1								
Manure Rating = Manure Rate x Manure Application Method x P Source Coefficient									
Source Factor = Soil Test Rating + Fertilizer Rating + Manure Rating									

PART B: Transport Factors

					CMU/Field ID				
Erosion	Soil Loss (ton/acre/yr)								
Runoff Potential	0 Drainage class is Excessively	2 Drainage class is Somewhat Excessively	4 Drainage class is Well/Moderately Well	6 Drainage class is Somewhat Poorly	8 Drainage class is Poor/Very Poorly				
Subsurface Drainage	0 None		1 Random		2* Patterned				
Contributing Distance	0 More than 500 feet	2 350 to 500 feet	4 200 to 349 feet	6 100 to 199 feet OR less than 100 feet with 35-foot buffer	9‡ less than 100 feet				
Transport Sum = Erosion + Runoff Potential + Subsurface Drainage + Contributing Distance									
Modified Connectivity	0.85 50-foot Riparian Buffer Applies to distances less than 100 feet		1.0 Grassed Waterway or None		1.1 Direct Connection Applies to distances greater than 100 feet				
Transport Sum x Modified Connectivity / 24									

P Index Value = 2 x Source x Transport					

* OR rapid permeability soil near a stream
‡ "9" factor does not apply to fields with a 35-foot buffer receiving manure.

P Index – Identifies Critical Source Areas

Site Conditions

Source

- Soil P
- Manure (rate, method, timing)
- Fertilizer (rate, methods, timing)

Transport

- Runoff
- Erosion
- Leaching

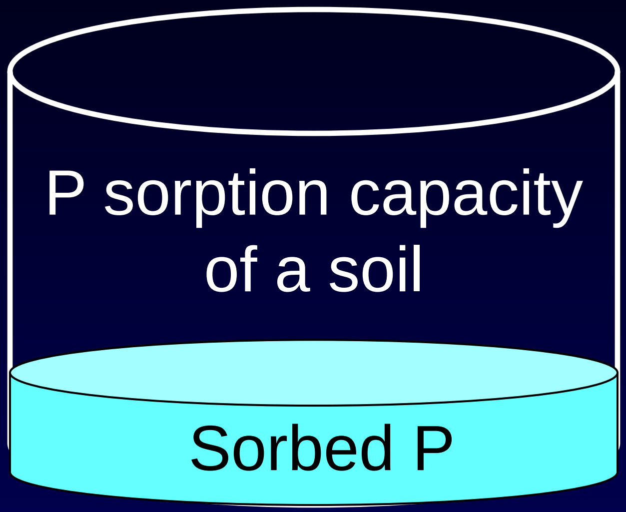
Site Rating

Management recommendation

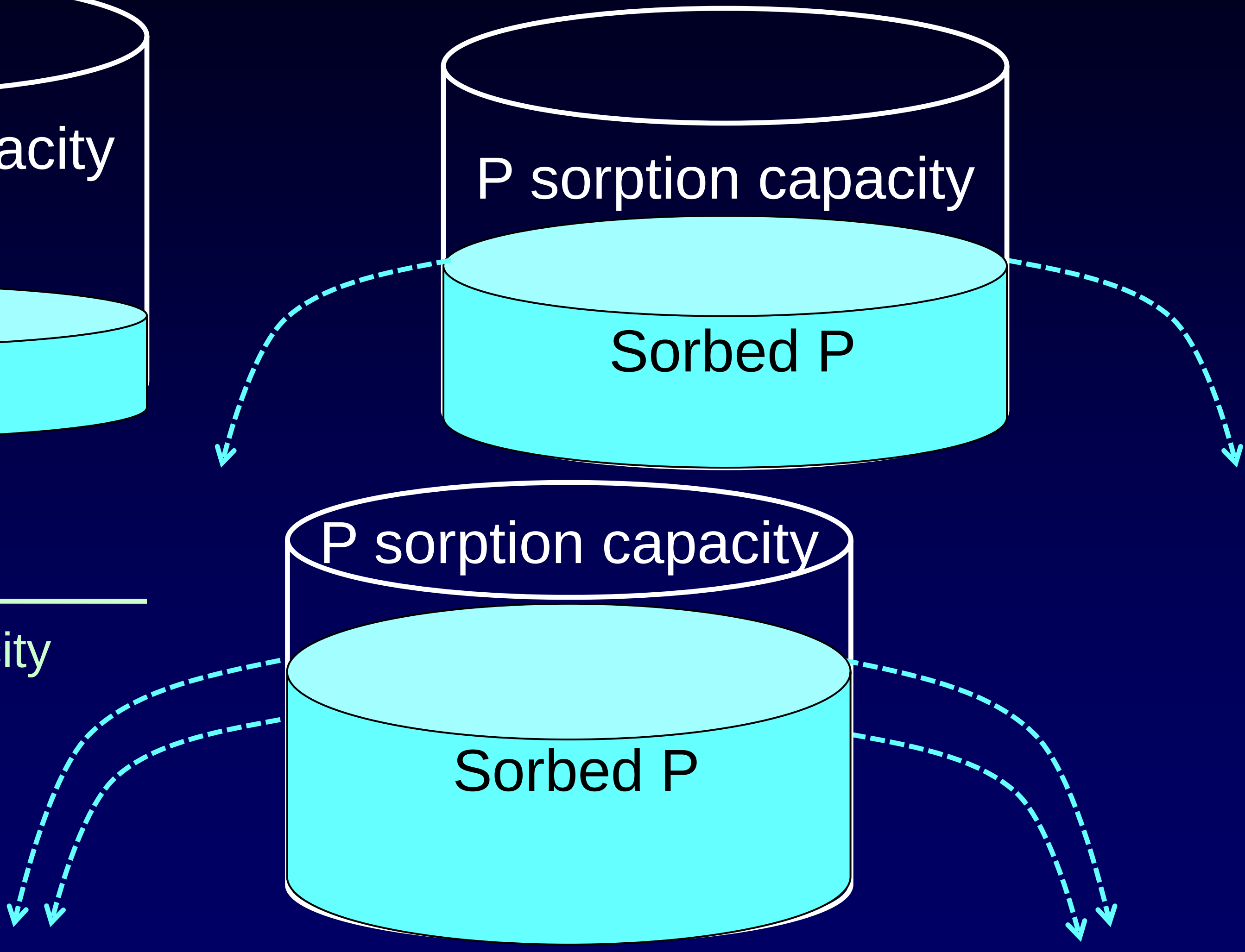
Table 2. Phosphorus index management guidance.

Value	Rating	Management Guidance
0 to 59	Low	Nutrients can be applied to meet the nitrogen crop requirement. Low potential for P loss. Maintenance of current farming practices is recommended to minimize the risk of adverse impacts on surface waters.
60 to 79	Medium	Nutrients can be applied to meet the nitrogen crop requirement. Medium potential for P loss. The chance for adverse impacts on surface waters exists. An assessment of current farm nutrient management and conservation practices is recommended to minimize the risk of future P loss.
80 to 99	High	Nutrients can be applied to meet the phosphorus crop removal. High potential for P loss and adverse impacts on surface waters. Soil and water conservation measures and P-based management plans are needed to minimize the risk of P loss.
100 or	Very High	No phosphorus can be applied. Very high potential for P loss and greater adverse impacts on surface waters. Conservation measures and a P-based management plan must be implemented to minimize the P loss.

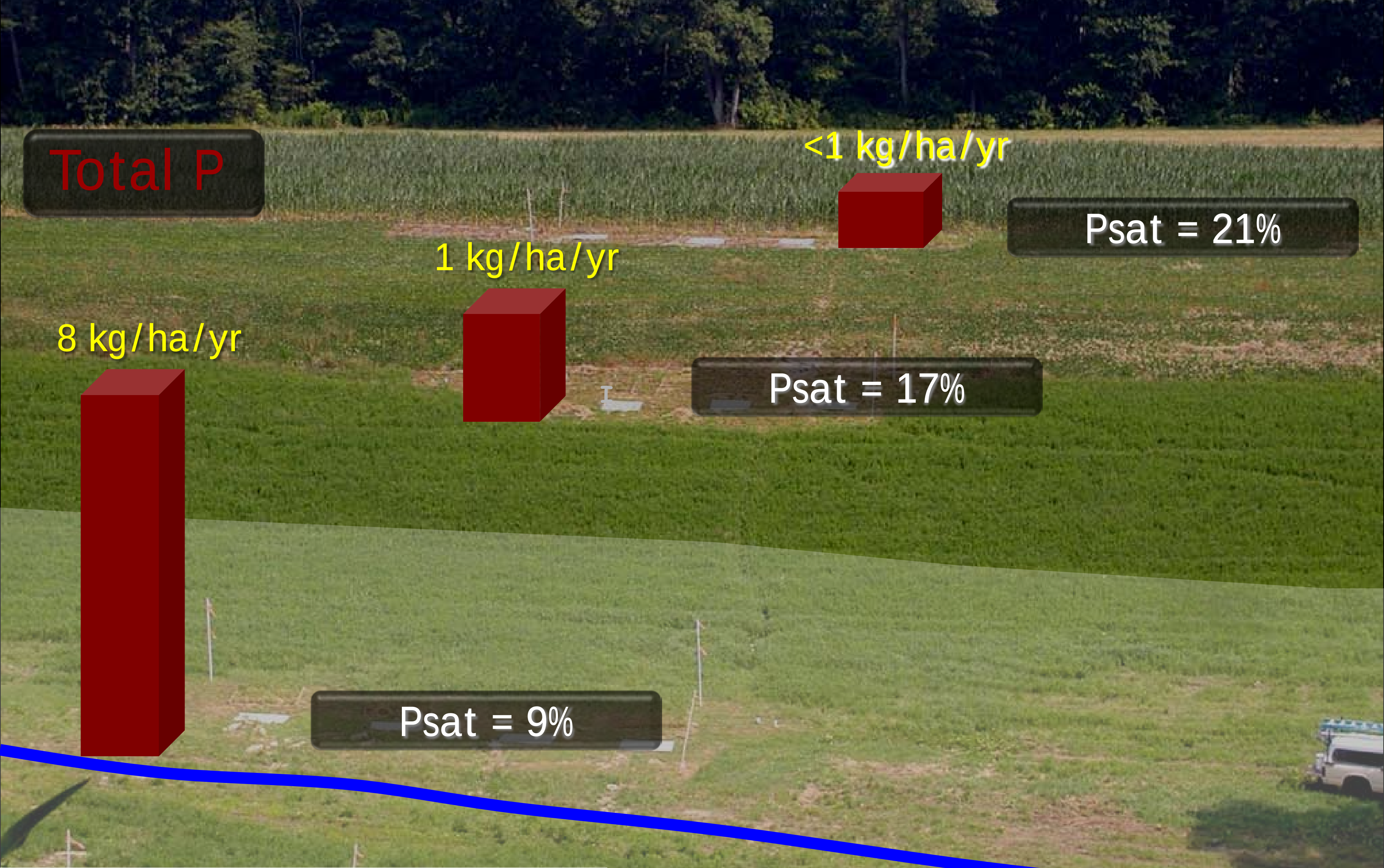
Soil P saturation – Indicator of runoff P



$$\frac{\text{Sorbed P}}{\text{P sorption capacity}}$$

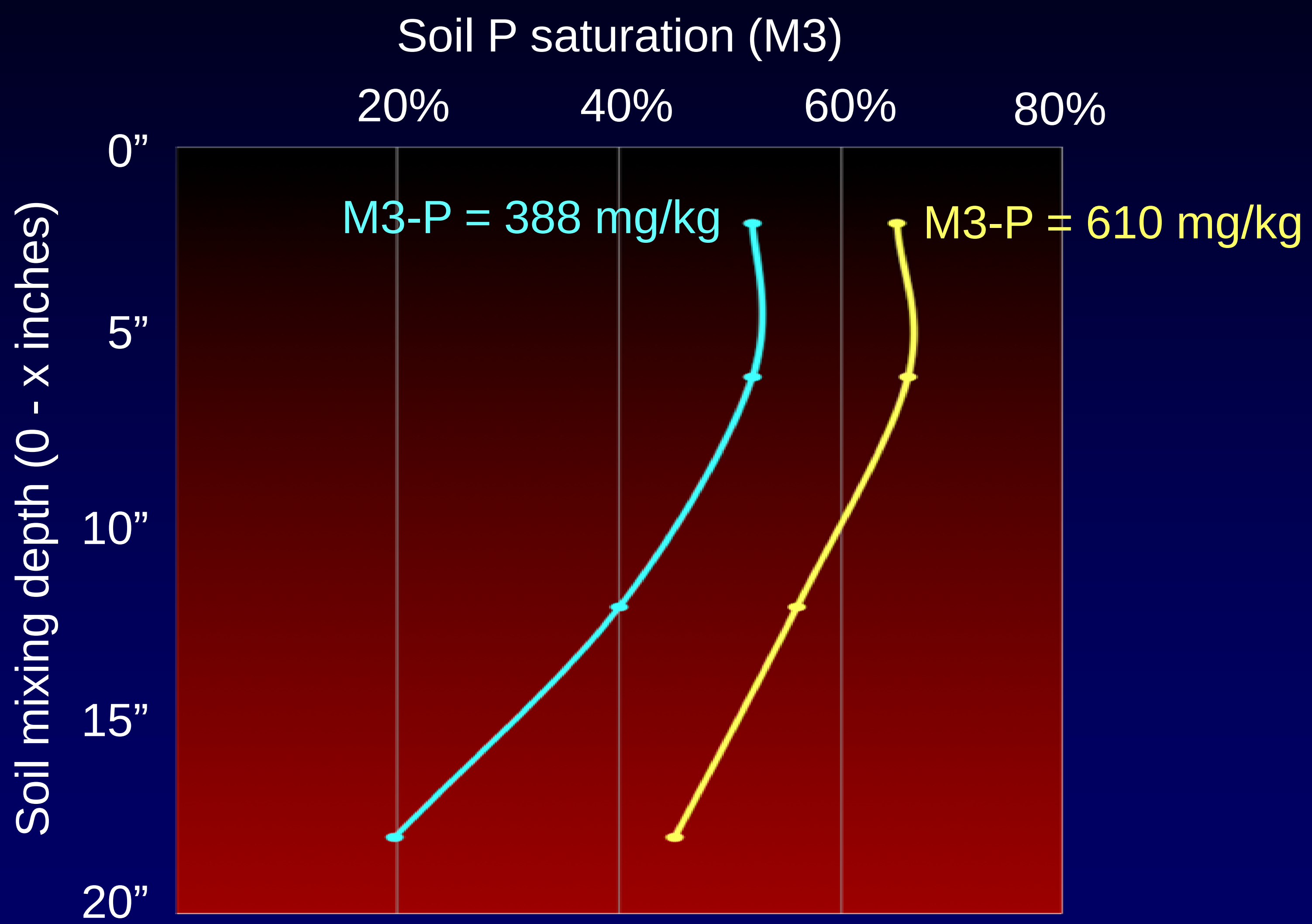


Soil P saturation – soil indicator only



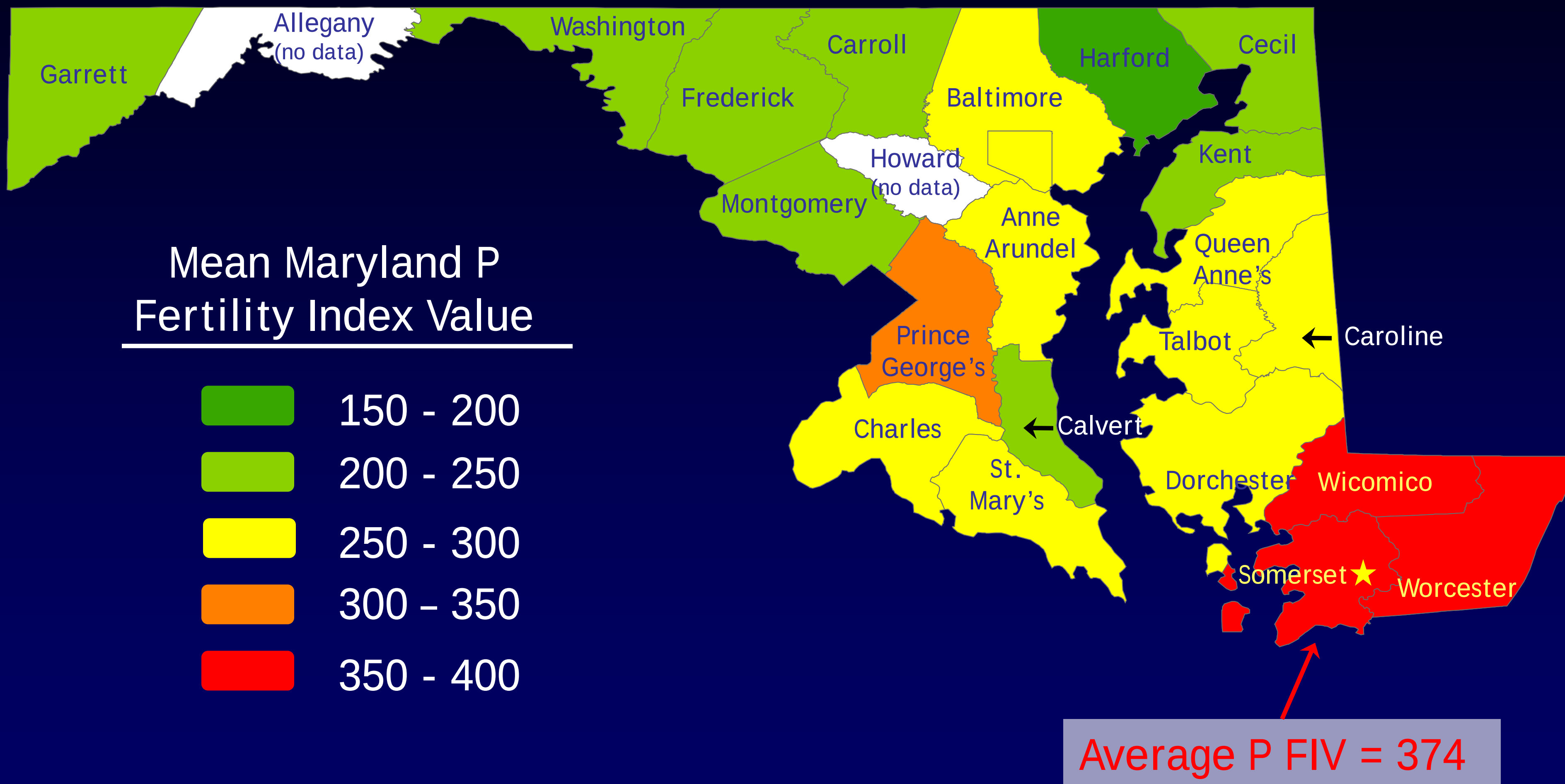
Buda et al. (2009) – J. Environ. Qual.

Soil P saturation – manipulated by tillage/sampling depth



Delmarva soils – long history of litter application

Purdue pelletizing plant runs under capacity
Crop farmers in northern Delmarva can't get litter.



Survey of fields where the Maryland P Index was run (FIV > 150 only)

Courtesy J. McGrath, Univ. Maryland

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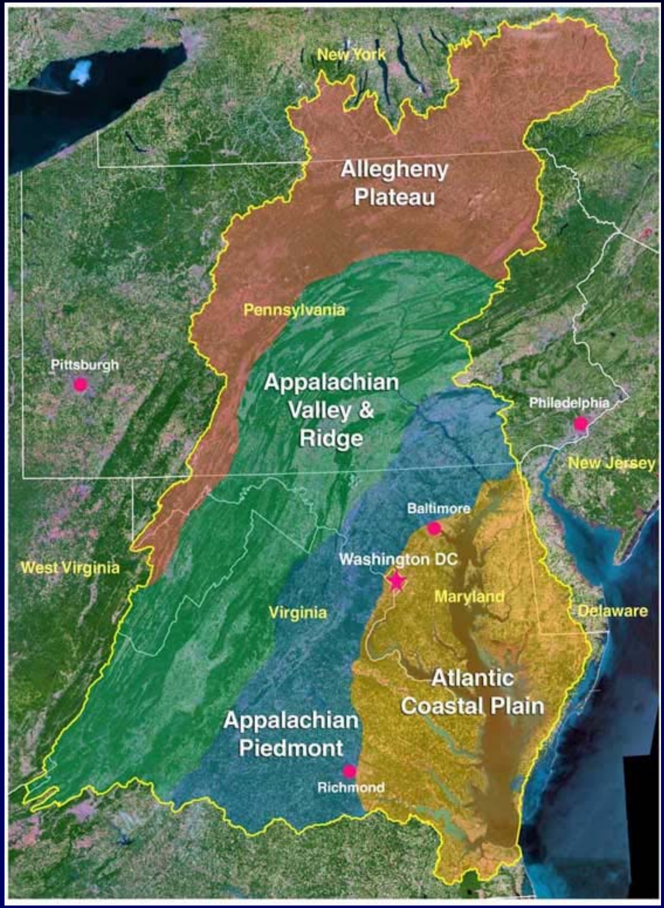
P Management Future

1. More stringent field restrictions

2. Regional manure management
   - Chesapeake P Index?
   - Manure transport/export

3. Improved representation of hydrology/transport
   - Leaching
   - Forecasting
   - Erosion – LiDAR DEMs

4. Dedicated practices
   - Legacy P



THANK YOU