




# Nutrient Management Planning Tools for Water Quality



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2020 National CAFO Roundtable  
Virtual Meeting 9-22-2020




## Today's presentation

- What tools do we have?
  - P risk assessment index
  - Process-based models
- What works where, when, & why
- Experience from local permitted CAFO on water quality
- Recent interactive web-based tools
- Some overarching conclusions





## A short history of the P Index & nutrient mgt.




1990

2020

NRCS convenes group of researchers & extension experts to develop a metric to assess the vulnerability of field to P runoff



## A short history of the P Index & nutrient mgt.





1990

1997

2020

- Several scientists meet with Maryland Gov. Gilchrest
  - Presented the science behind P-based mgt.
  - Case made for P loss assessment rather than soil test P thresholds alone





## A short history of the P Index & nutrient mgt.

1990

1998

2020

Maryland implements restrictive soil test P thresholds for nutrient management & P applications





## A short history of the P Index & nutrient mgt.

1990

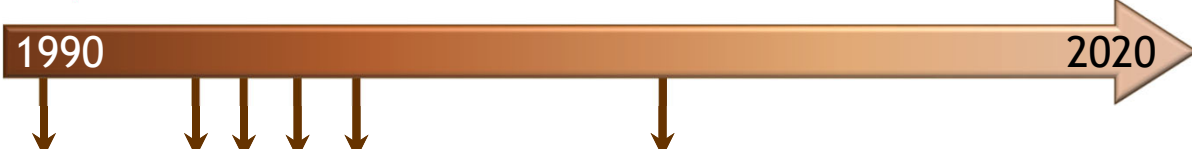
2000

2020

- Joint U.S. EPA & USDA Initiative requires P loss assessment prior to applying P
- Maryland adopts the P Index into their nutrient management planning
  - Top 10% fields assessed
  - Limited resources to assess all fields





## A short history of the P Index & nutrient mgt.




1990 2020

2009 - undergoes SERA-17 review

- Disparity among Indices
  - Varied with soils, topography, & state priorities
- Often, not leading to a decline in soil P nor improvement in water quality
  - Legacy effects
- Perceived as farmer friendly





## A short history of the P Index & nutrient mgt.



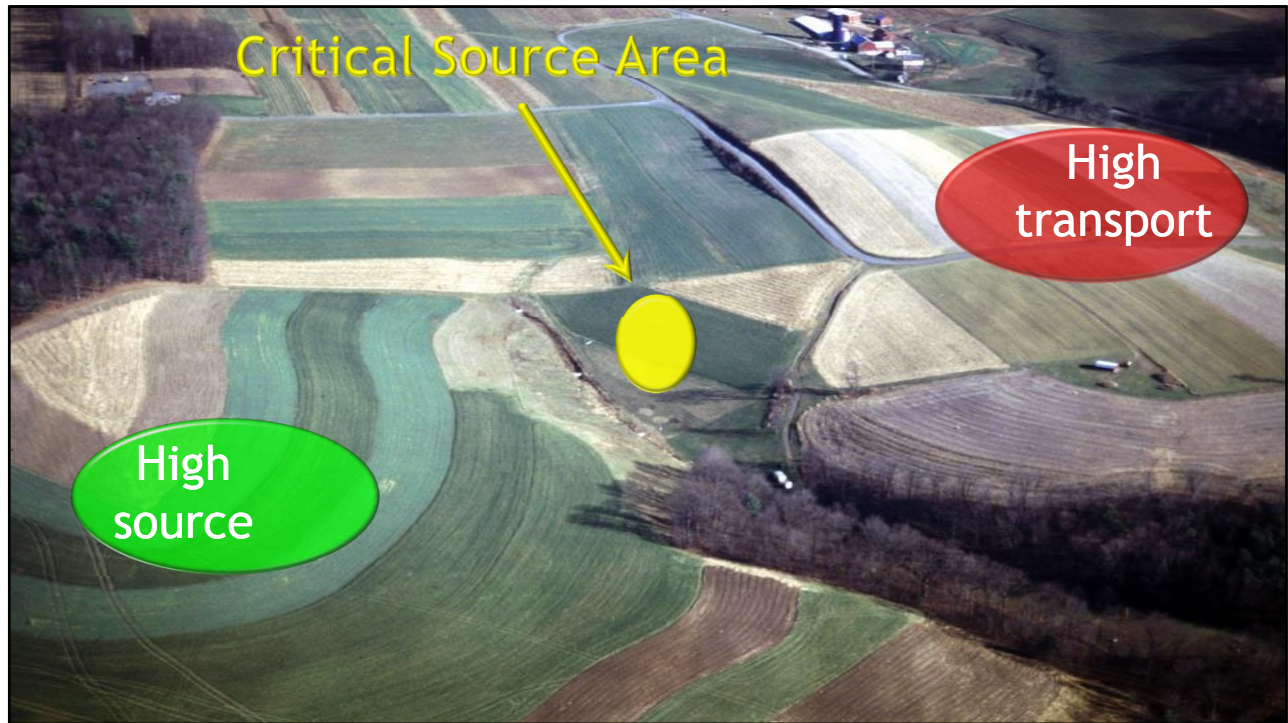
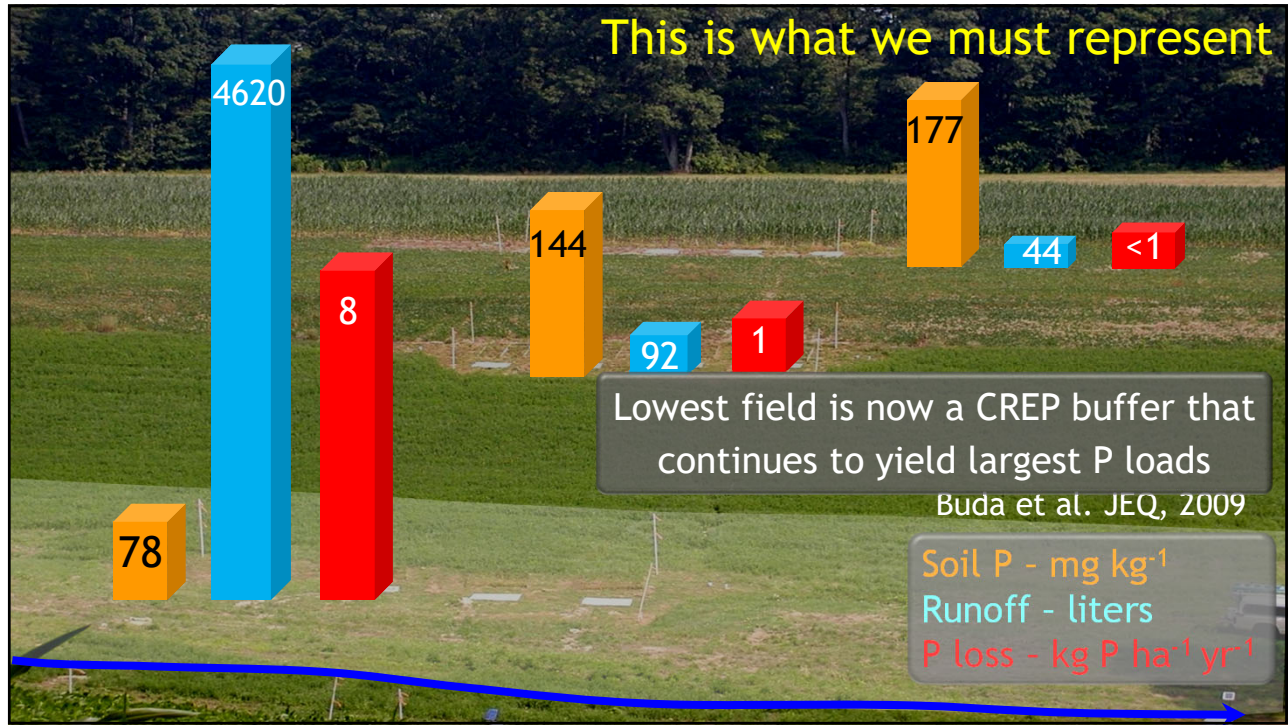
1990 2020

2010

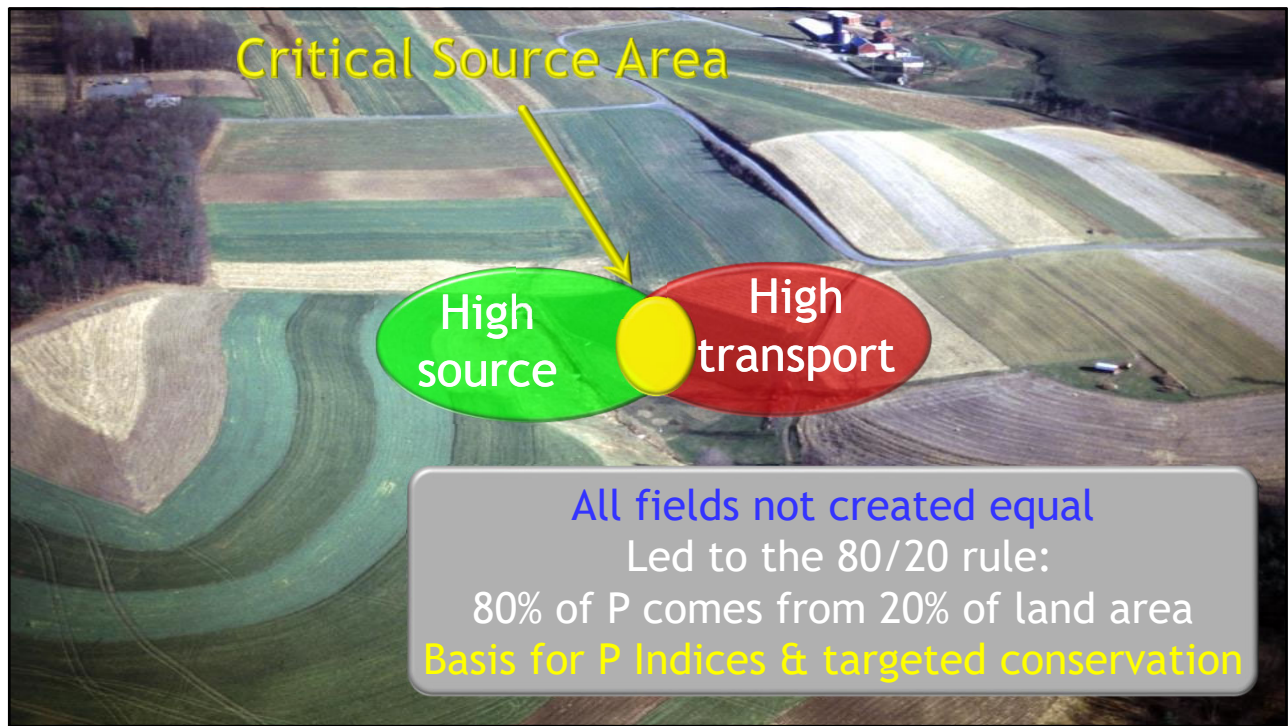
- Main recommendations of SERA-17 review
  - Mainly interpretation not science that is lacking
  - All Indices must represent local P source & transport factors
  - Must have a zero P application category
  - States must show Indices are directionally & magnitudinally correct











## P Index risk assessment

### Source





- Soil P content
- Added P
  - Rate, method, & timing of fertilizer & manure
  - Source P solubility

### Transport

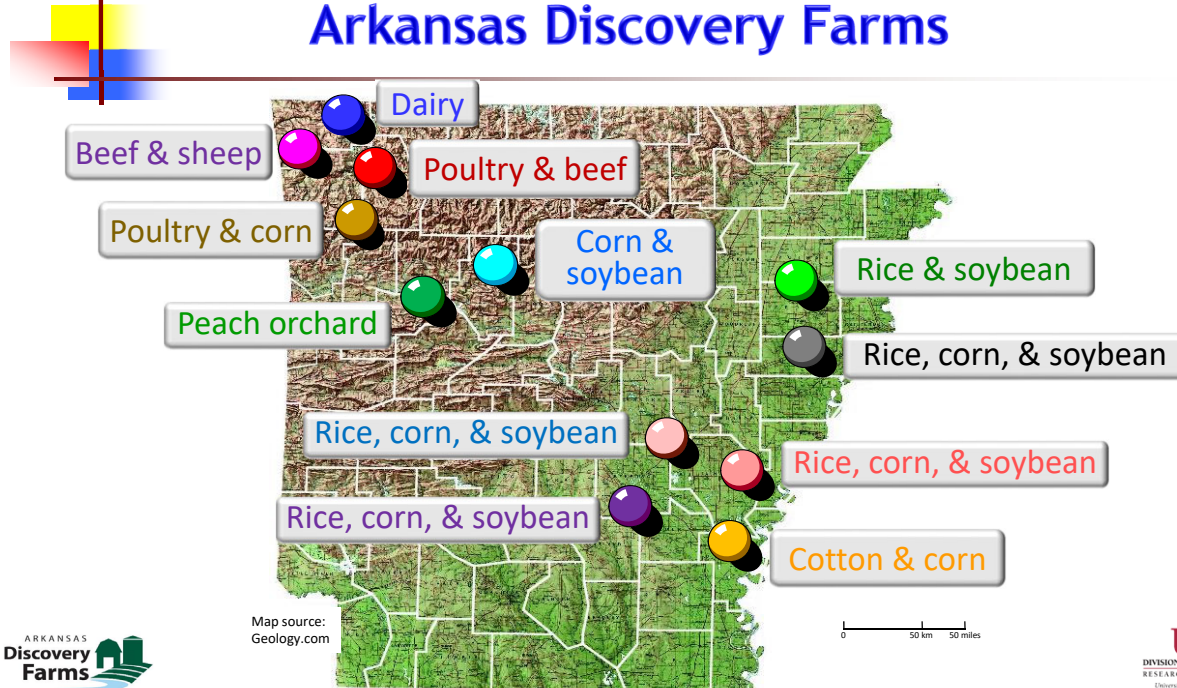
- Runoff potential
- Erosion potential
- Flooding frequency


### Cons. Practice

- Ponds
- Field borders
- Riparian buffers
- Stream fencing
- Grassed waterway

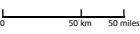






## Arkansas Discovery Farms





Map source: Geology.com









### Edge-of-field runoff 2015 to 2019 average

		kg <sup>-1</sup> ha <sup>-1</sup> yr <sup>-1</sup>	% applied
<b>Nitrogen</b>			
Corn	Dumas	1.9	1.5
Cotton	Dumas	6.7	4.6
Pasture	Elkins	0.6	0.2
Soybean	Atkins	3.6	1.3
<b>Phosphorus</b>			
Corn	Dumas	0.4	1.5
Cotton	Dumas	1.0	2.8
Pasture	Elkins	0.2	0.2
Soybean	Atkins	1.2	1.6

### Outcomes of field monitoring

- Conservation practices (cover crop, reduced till, & irrigation mgt.) decreased nutrient runoff
- Measured losses much less than model estimates used to target conservation funding & set baselines for possible Mississippi River Basin nutrient trading program

kg ha <sup>-1</sup> yr <sup>-1</sup>	Nitrogen	Phosphorus
SWAT-APEX predicted loss	26.3	3.5
Discovery Farm EOF sites	0.5 - 13.2	<0.1 - 2.5



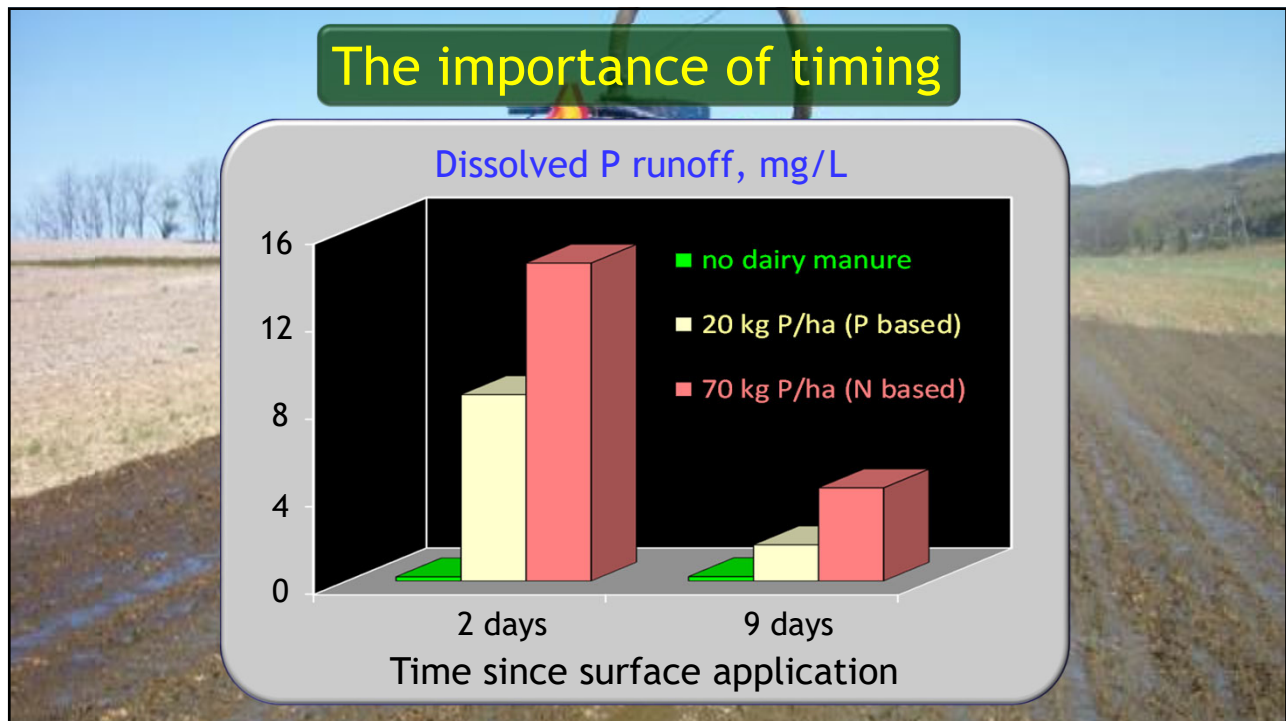


## Models & nutrient management planning

- Considerable time & effort to set up, calibrate, & verify models
- Data required not readily available, especially to farmers
- Models can arrive at the right conclusion for the wrong reasons
- Models can perform well when calibrated with local data
- Uncertainty in model estimates can be  $\pm 100\%$



Sharpley et al., 2017 "Evaluation of P Site Assessment Tools: Lessons from the USA. J Environ. Qual. 46:1250-1256.

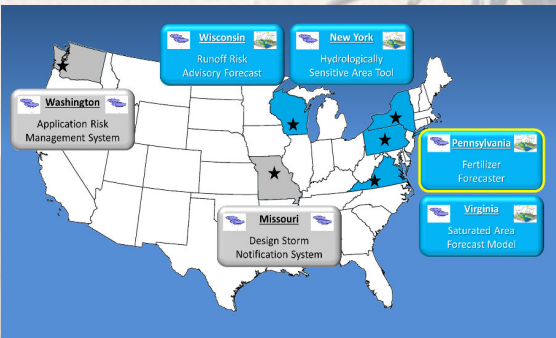


## When & where to apply nutrients?

Checking the latest 5-day runoff forecast

### Past accomplishment

An evaluation of six runoff forecasting platforms showed promising applications to operational decision making in nutrient management



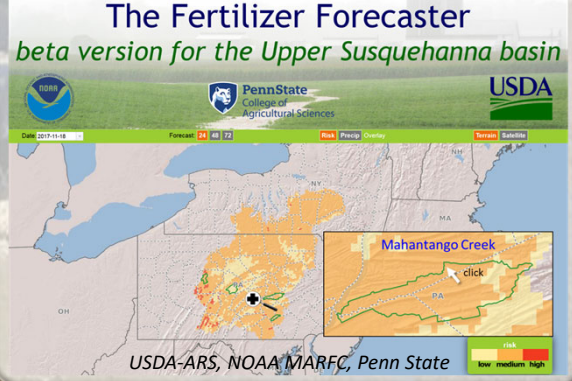
*Va. Tech, USDA-ARS, others; Easton et al. (2017)*

### Current research

Ongoing research is assessing the accuracy & skill of short-range runoff forecasts for use in guiding fertilizer & manure applications

#### The Fertilizer Forecaster

*beta version for the Upper Susquehanna basin*



*USDA-ARS, NOAA MARFC, Penn State*

## Monitoring water quality impact of CAFO in Buffalo River watershed



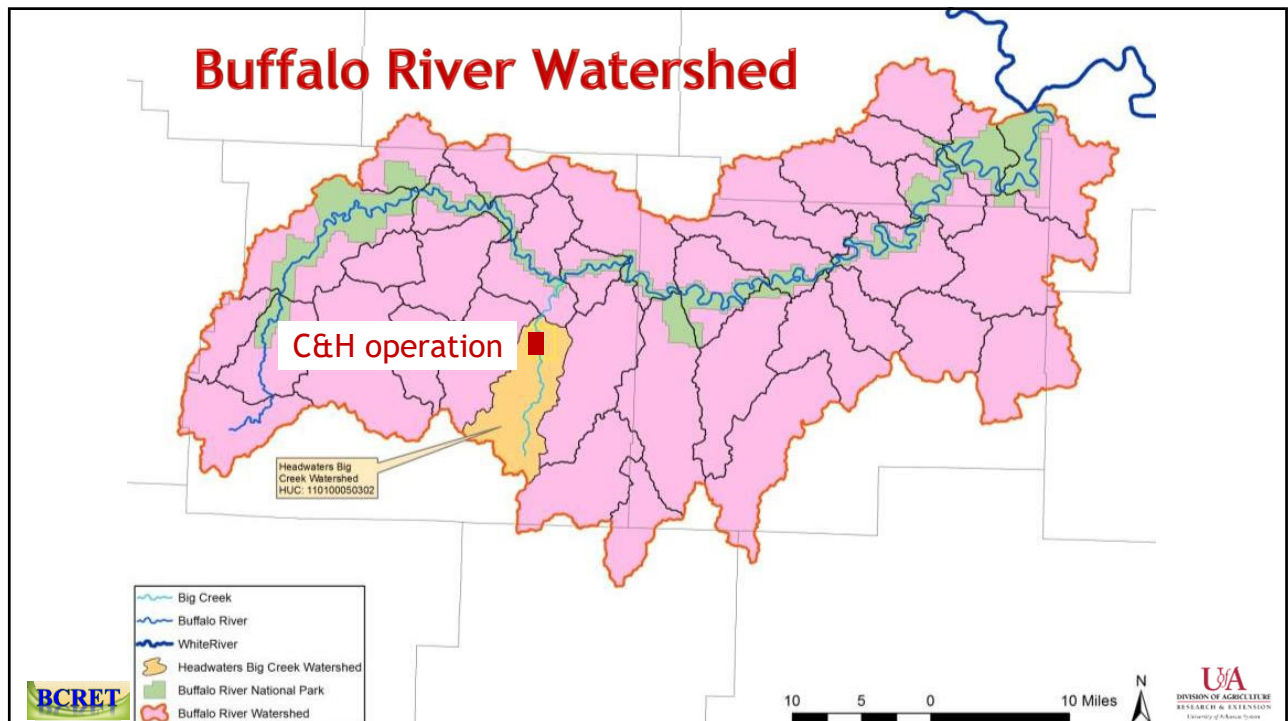
- Farm established in early 2013
- Capacity for 6,500 hogs; operating at 2,500 pigs





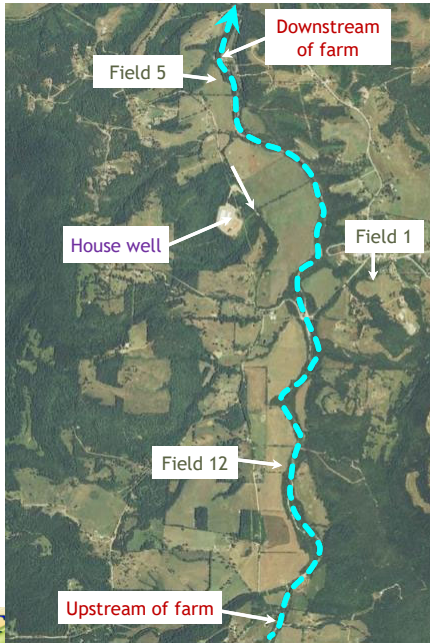
### Project goals

- ✓ Assess impact of farm operations on water quality of springs, streams & ground water on & adjacent to the farm
- ✓ Monitor fate & transport of nutrients & bacteria from land-applied swine slurry
- ✓ Provide transparent & unbiased science for landowner & State to make decisions





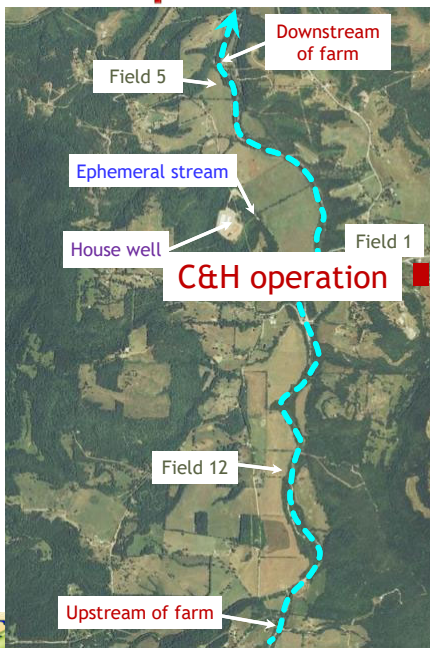
### Water sample collection locations



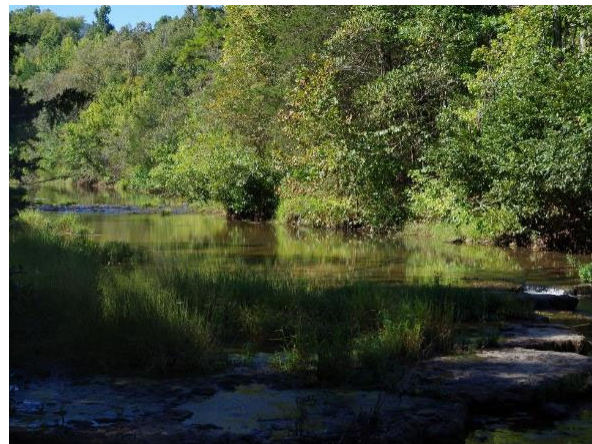
### Upstream site



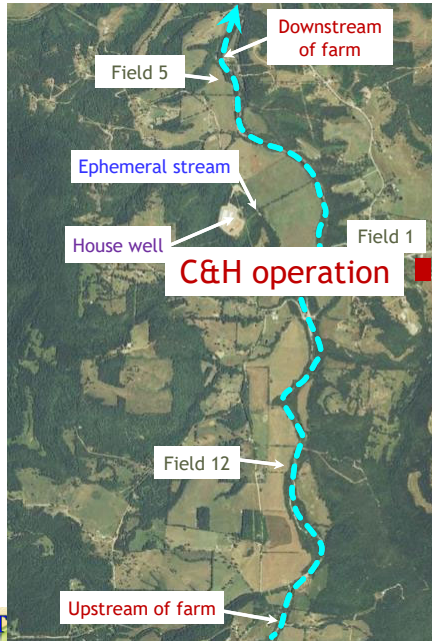
### Water sample collection locations



### Downstream site



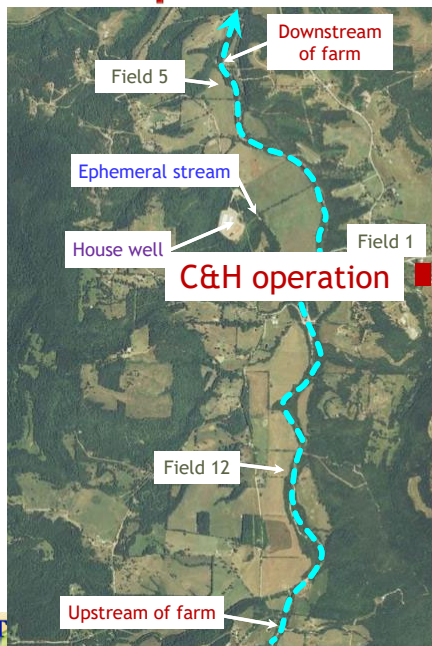
## Water sample collection locations



## House well



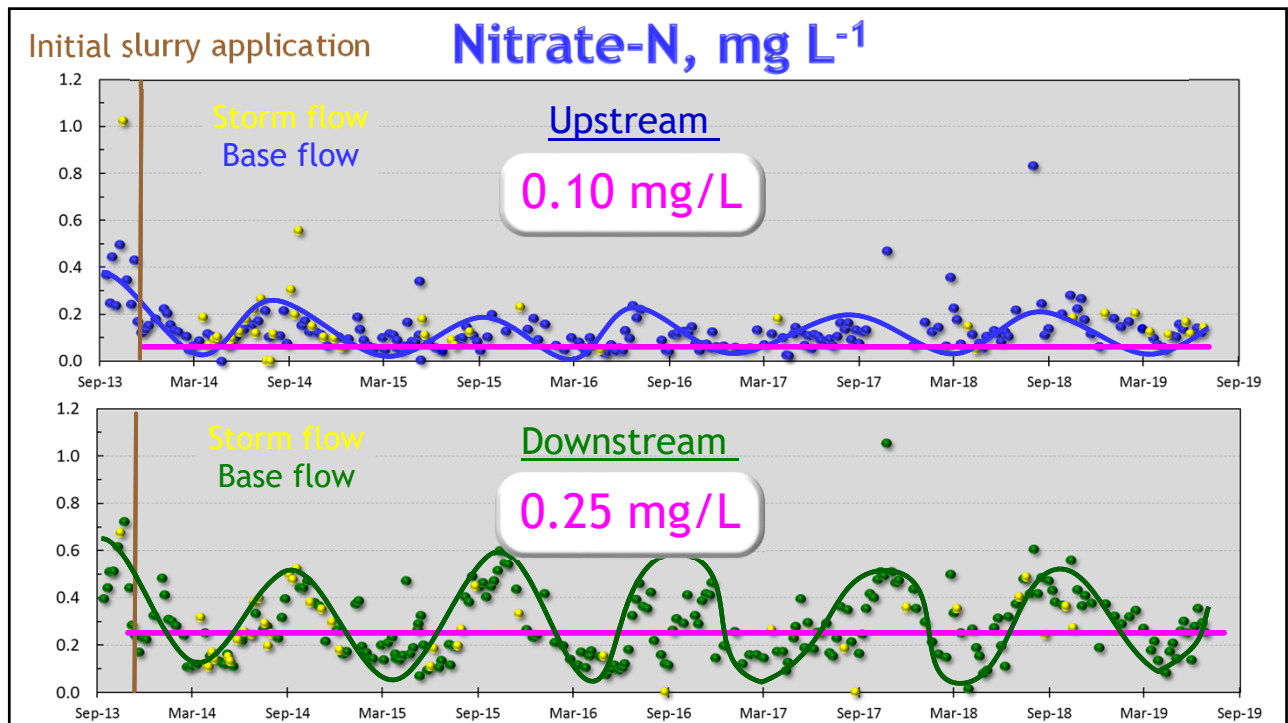
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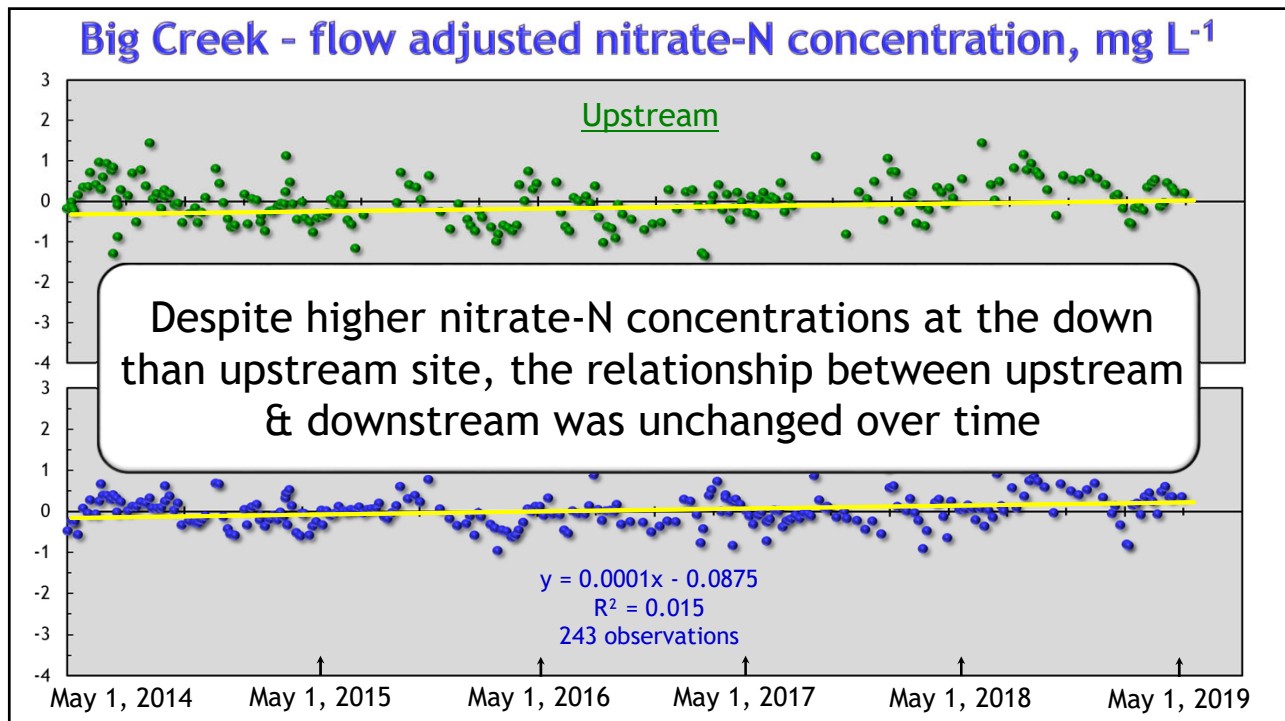
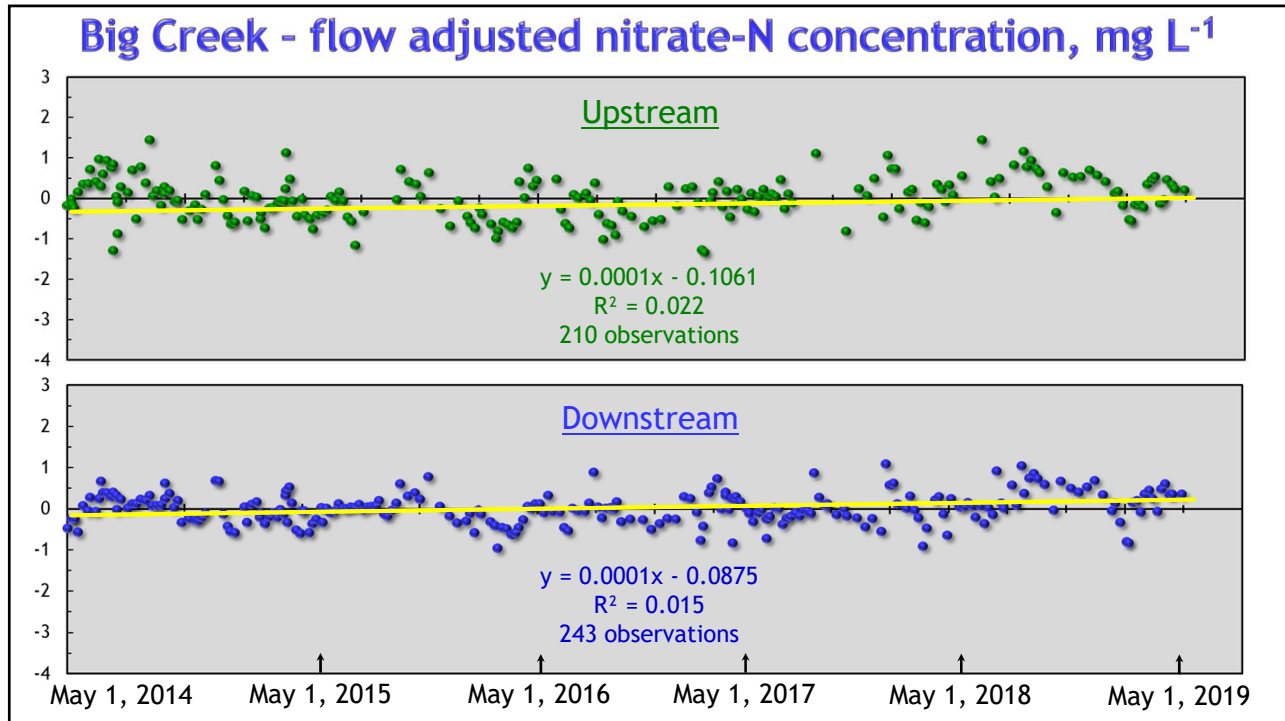
## Water quality assessment

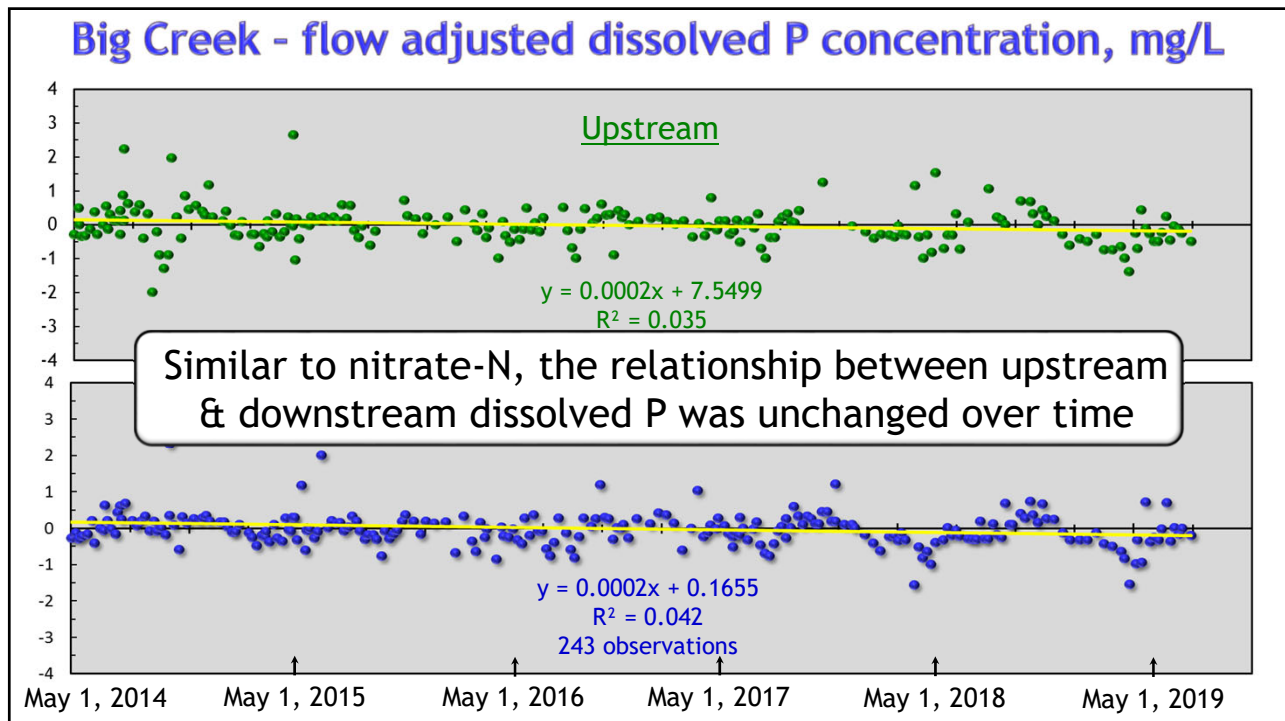
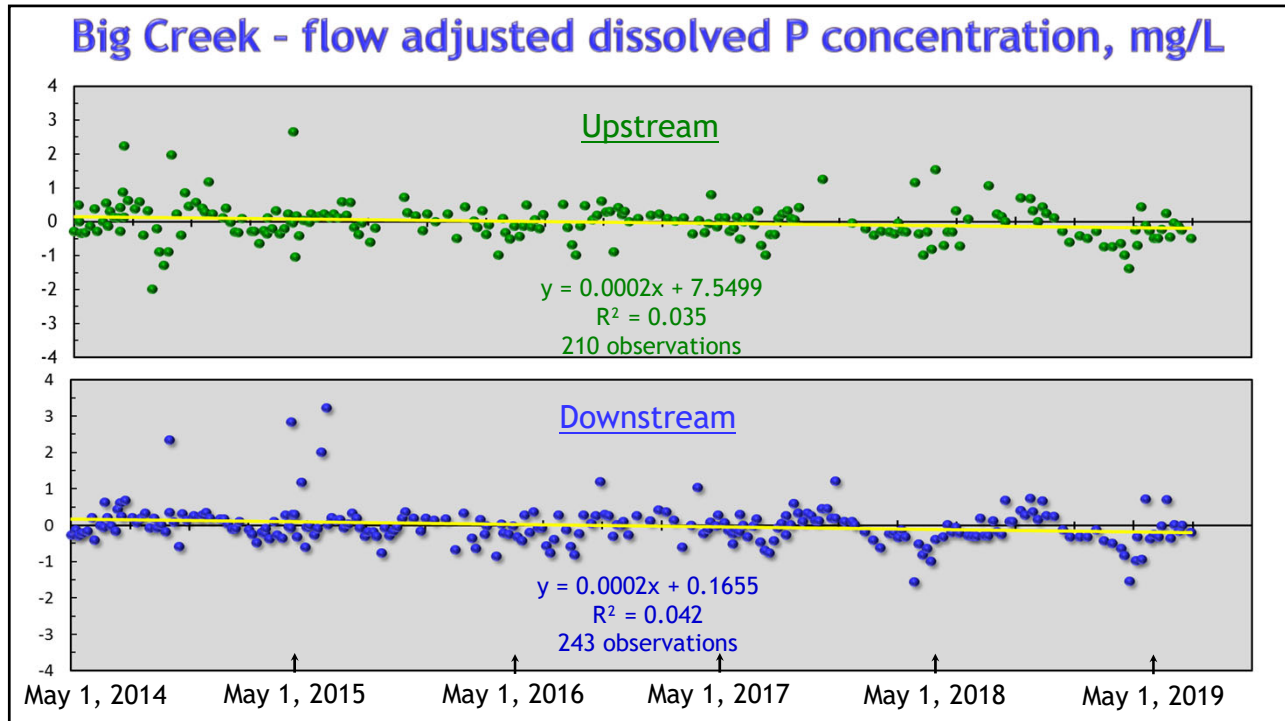
- Storm & weekly sampling of base flow for
  - N, P, sediment, bacteria
- Field runoff from 2 application fields & 1 control

















<p><b><u>Field 1</u></b> <b>15.6 acres</b></p> <p><b><u>P &amp; N applied</u></b> <b><u>as slurry</u></b></p> <p><b>94 lbs P/ac/yr</b> <b>100 lbs N/ac/yr</b></p> 	
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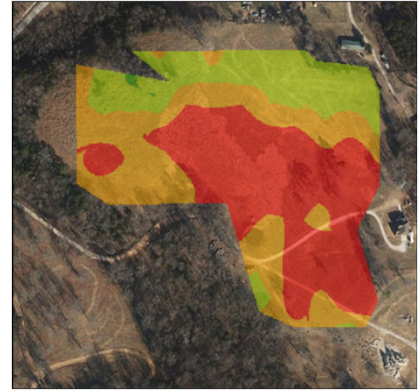
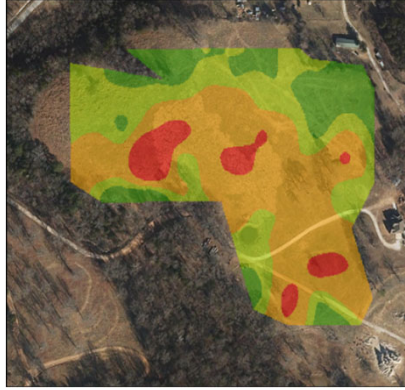
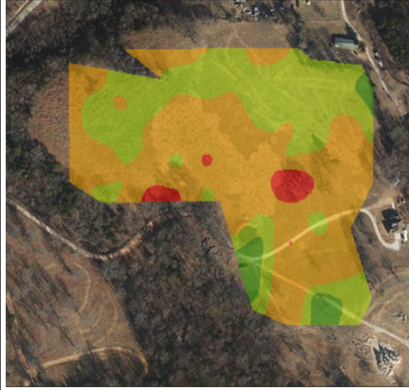


**Field 1: Soil test P of 0 to 4 inches**

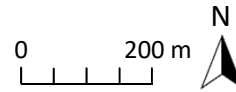
2014

2016

2018



Mehlich-3 extractable soil P, mg kg<sup>-1</sup>



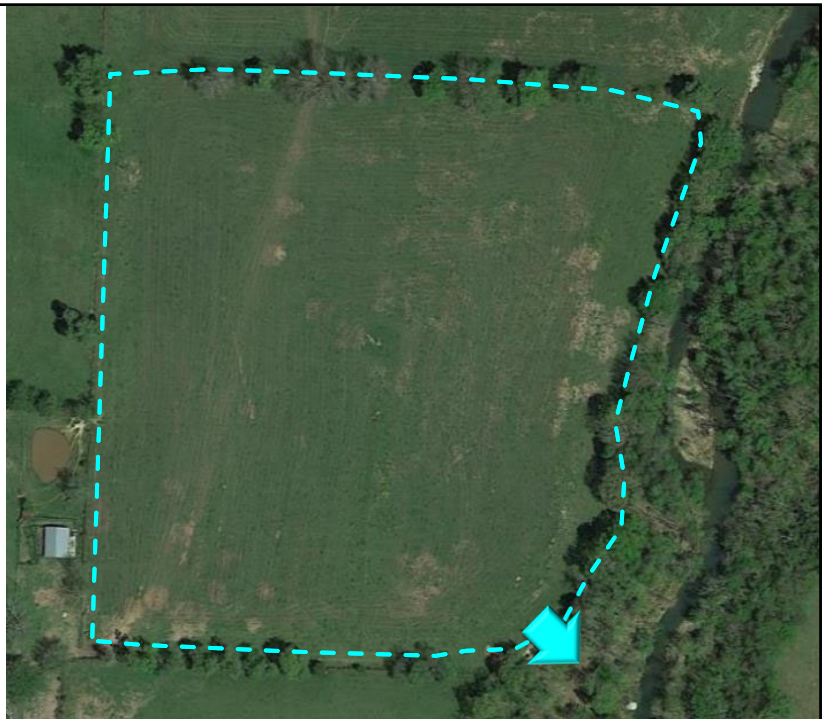
**Field 12:**

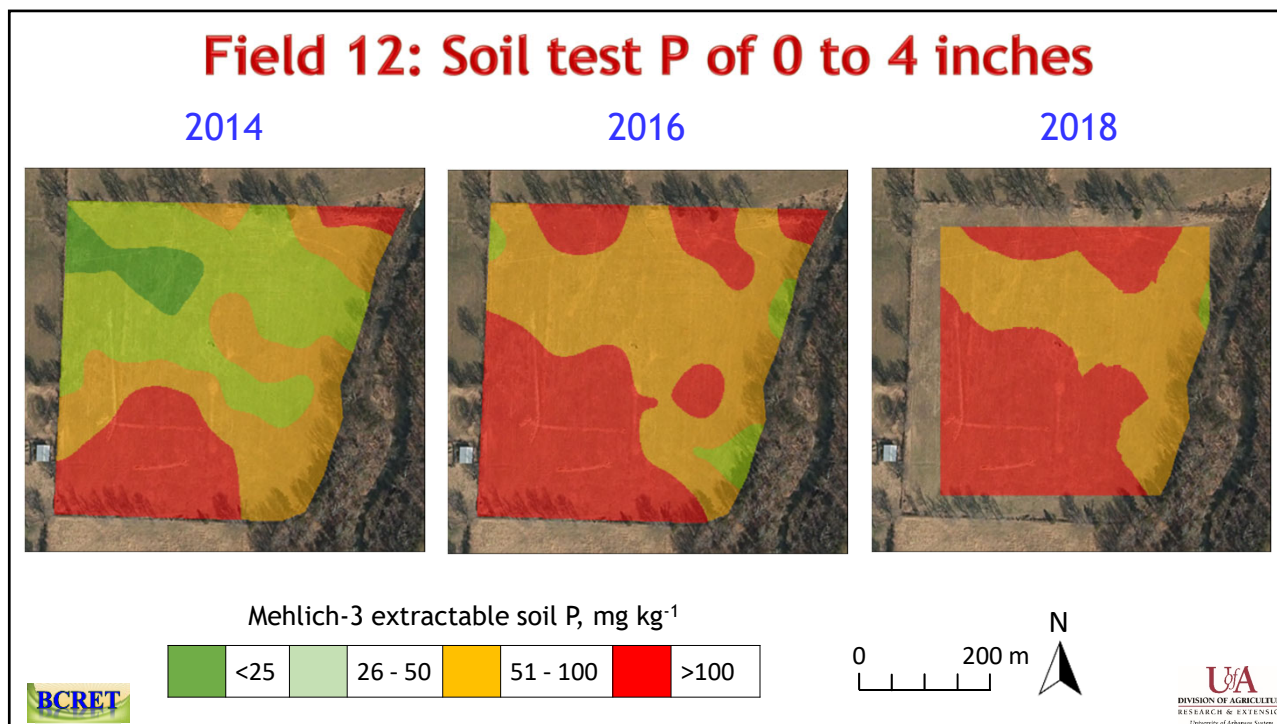
**28.7 acres**

**P & N applied**  
**as slurry**

**75 lbs P/ac/yr**

**90 lbs N/ac/yr**



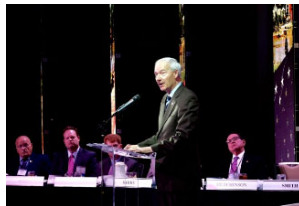


### What did we learn?

- ✓ Nitrate-N greater downstream than upstream of C&H **but** relationship between up & down unchanged 2014 to 2019
- ✓ Soil P accumulating in permitted fields **but** grazing mgt. complicates cause & effect
- ✓ Transparency is critical **but** if taken out of context, can lead to false conclusions
- ✓ Science informs ~75% **but** extreme of opinion not swayed



### Governor: C&H Hog Farm Will End Its Operation in Buffalo River Watershed



Gov. Hutchinson announced that the state reached an agreement with C&H Hog Farms to end its operation in the Buffalo River watershed.

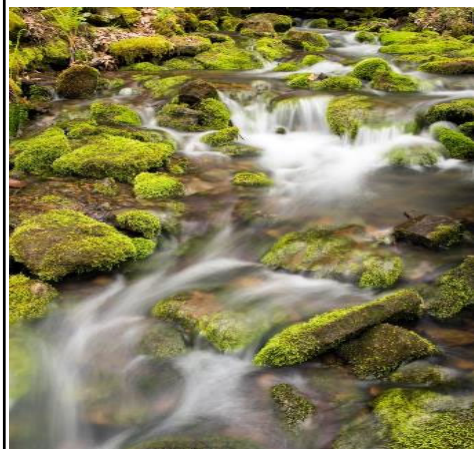
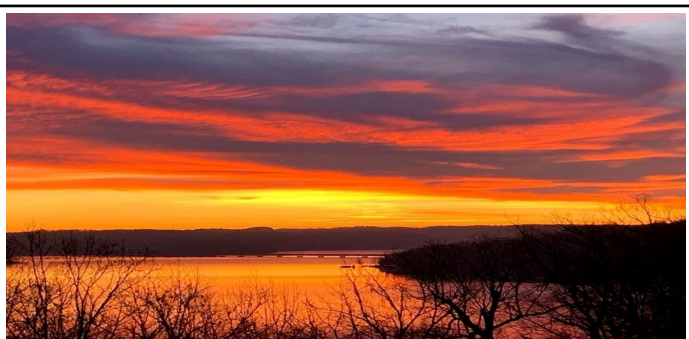
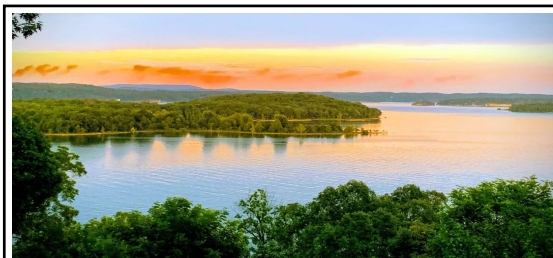
The governor called protecting the Buffalo River a priority, & that while operators of the hog farm did nothing wrong, the state never should have granted them a permit to operate in the area.

### Overarching conclusions

- Use the right tool for the right job
  - P Indices area field-based guide to on-farm nutrient management
  - Models are valuable research tools & for scenario comparison
  - All have uncertainty
- Nutrient management planning via NRCS 590 can decrease the potential for P runoff
- But, management needs to be adaptive & an ongoing dialogue between planner & farmer
- Recent web-based tools that draw on digitized & available data bases expand functionality, reliability, & ease of use



# ACWA National CAFO Roundtable - September 22 to 24



**Thank you**

