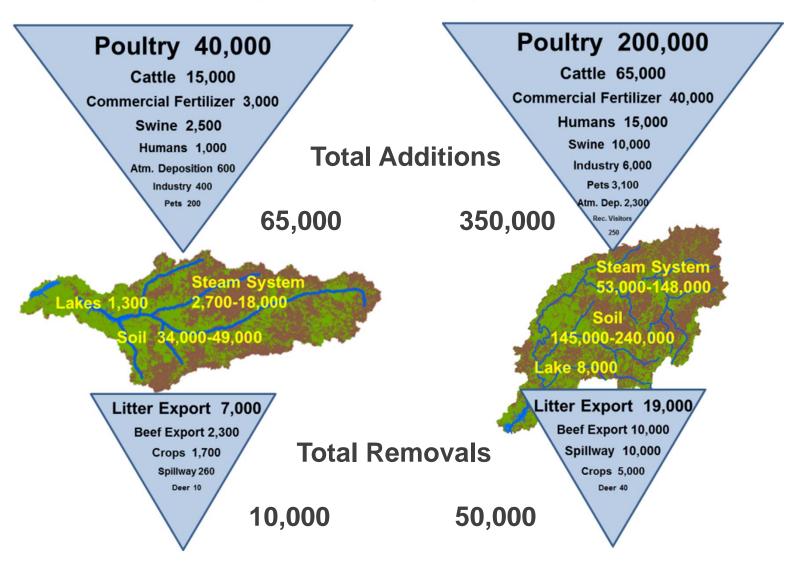
## USING SWAT TO ENHANCE WATERSHED-BASED PLANS IN THE KE EUCHA-SPAVINAW AND ILLINOIS RIVER WATERSHEDS OF OKLAHOMA



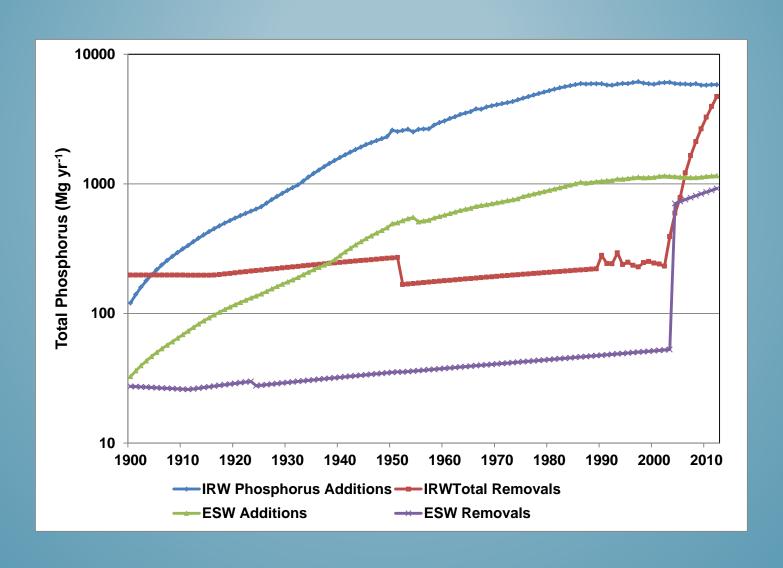
#### PROJECT OBJECTIVES

- 1. Determine major phosphorus sources in Eucha-Spavinaw and Illinois River watersheds
- 2. Setup and calibrate SWAT models with current data
- 3. Estimate Oklahoma's current violations of phosphorus standards
- 4. Determine scenarios Oklahoma needs to implement to meet standards

### PHOSPHORUS ADDITIONS (Mg) AND REMOVALS FROM 1900-2012

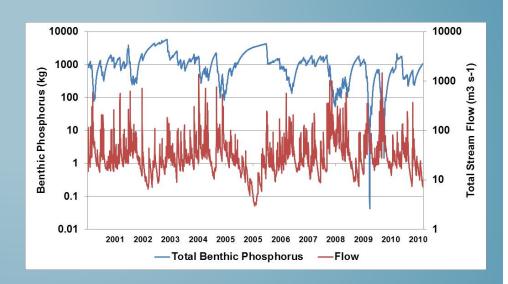


### PHOSPHORUS ADDITIONS AND REMOVALS FROM 1900-2012

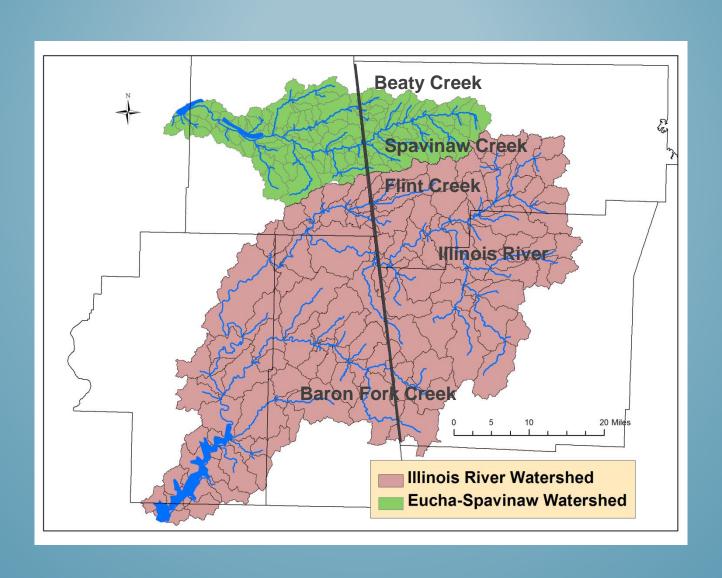


#### **SWAT MODEL**

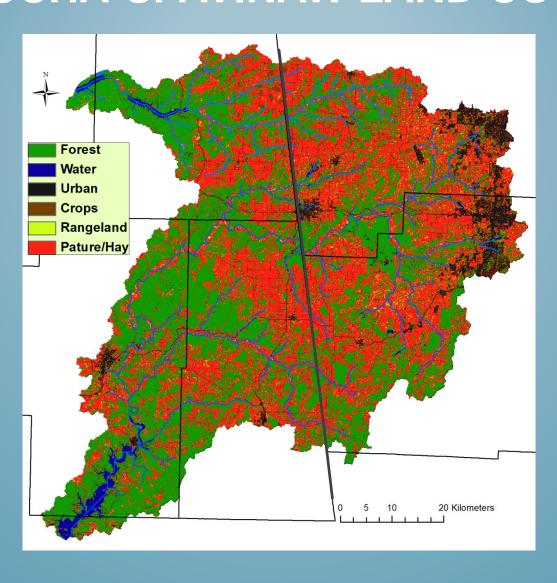
- > SWAT 2012 utilized with the new manure and in-stream phosphorus sub-models
- > Data Needs
  - Weather
  - Land Cover
  - Digital Elevation Model
  - SSURGO Soils Layer
  - Streams and Ponds
  - Point Sources
  - Soil Test Phosphorus
  - Land Use Management Data



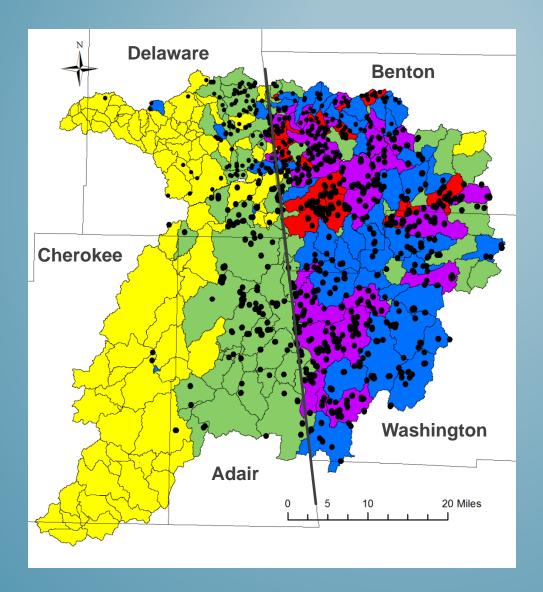
## ILLINOIS RIVER AND EUCHA-SPAVINAW WATERSHEDS

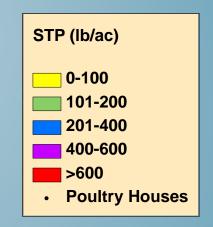


# ILLINOIS RIVER AND EUCHA-SPAVINAW LAND COVER



## LITTER PRODUCTION AND SOIL TEST PHOSPHORUS





	# of Broilers
County	(million)
Benton	120
Washington	115
Delaware	50
Adair	30
Cherokee	2

# AERIAL IMAGERY SHOWING POULTRY HOUSES



#### **MODEL PERFORMANCE**

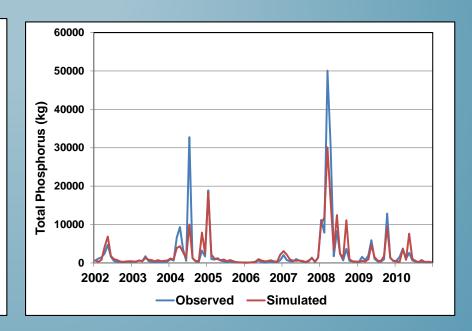
#### Illinois River near Tahlequah

- Flow: 0.7% relative error; NSE=0.81
- Total P: 3.4% relative error; NSE=0.75

### 200000 160000 120000 40000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 Observed Simulated

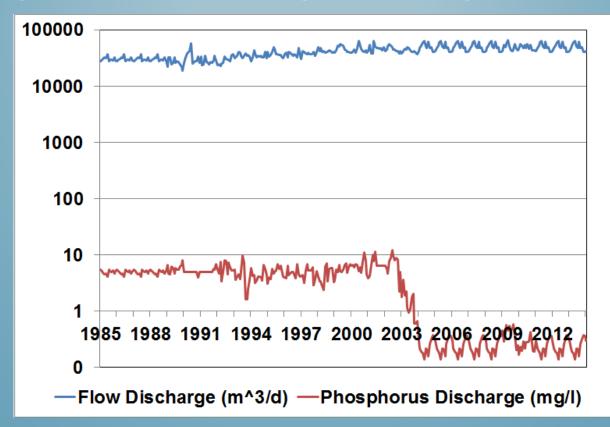
#### Spavinaw Creek near Colcorde

- Flow: 0.5% relative error; NSE=0.83
- Total P: 10% relative error; NSE=0.73



#### **UPDATED SWAT MODEL**

- Weather: 2004-2013
- > Export of poultry litter: 80-90%
- Decrease in point source phosphorus discharges
  - Decatur, Arkansas: discharge 2000: 30 kg d<sup>-1</sup> Currently: 1 kg d<sup>-1</sup>
  - Springdale, Arkansas: discharge 2000: 280 kg d<sup>-1</sup> Currently: 12 kg d<sup>-1</sup>



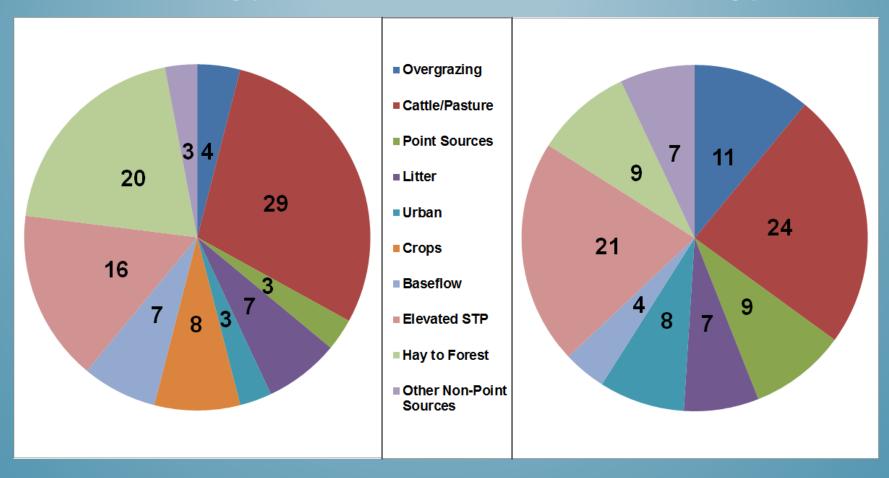
**Springdale WWTP** 

### SOURCE OF PHOSPHORUS BY LAND COVER

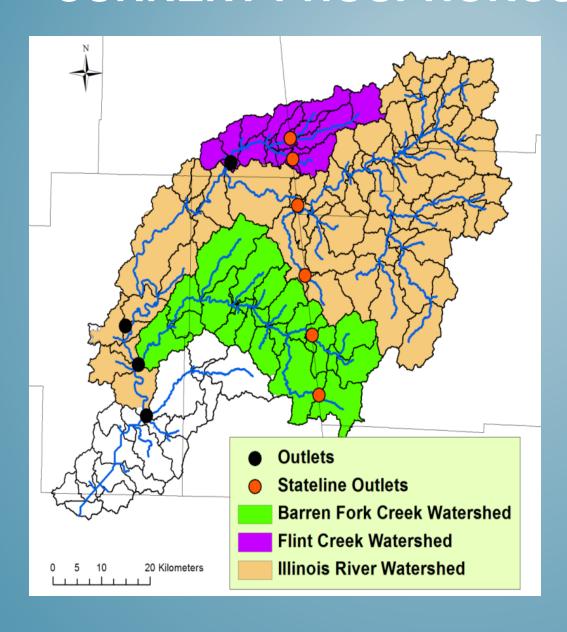
#### Updated Model 2004-2013

Entering Lake Eucha: 30,000 kg yr<sup>-1</sup>

Entering Lake Tenkiller: 190,000 kg yr<sup>-1</sup>



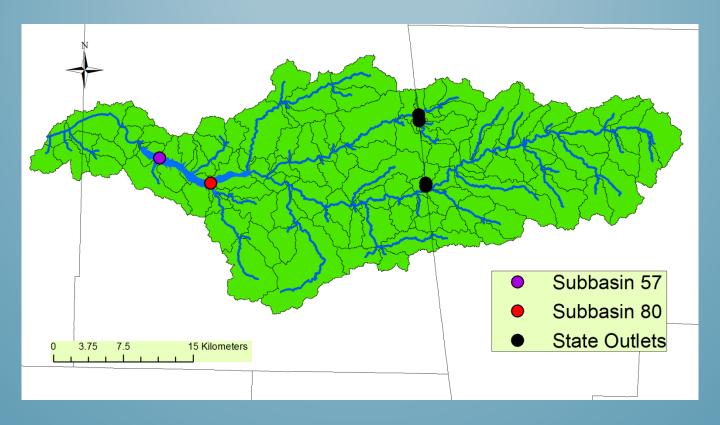
#### **CURRENT PHOSPHORUS STANDARDS**



Standard will be supported if fewer than 25% of the monthly geometric mean concentrations exceed 0.037 mg I<sup>-1</sup> TP.

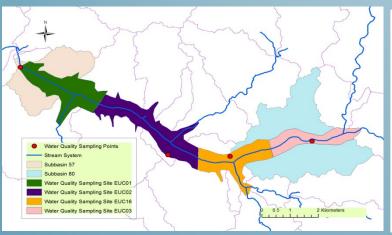
#### **CURRENT PHOSPHORUS STANDARDS**

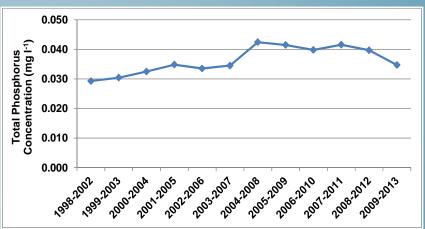
The long-term average TP concentration at a depth of 0.5 meters below the surface shall not exceed 0.0168 mg l<sup>-1</sup> in Eucha Lake and 0.0141 mg l<sup>-1</sup> in Spavinaw Lake.



## LAKE EUCHA WEIGHTED AVERAGE PHOSPHORUS CONCENTRATION

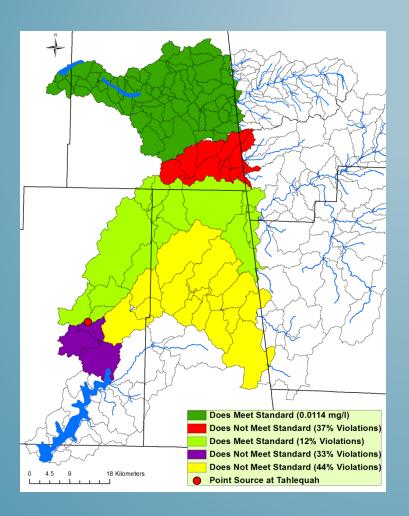
- Good correlation (R<sup>2</sup> 0.78) between weighted average concentration and concentration at subbasin 57
- To meet standard in entire lake, correlation (R<sup>2</sup> 0.86) calculated between sampling site EUC03 and subbasin 80



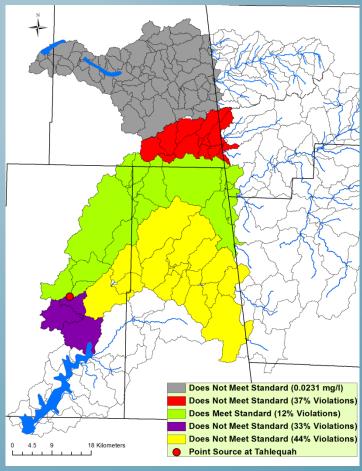


#### **CURRENT EXCEEDANCES IN OKLAHOMA**

Lake Eucha P concentration from weighted average



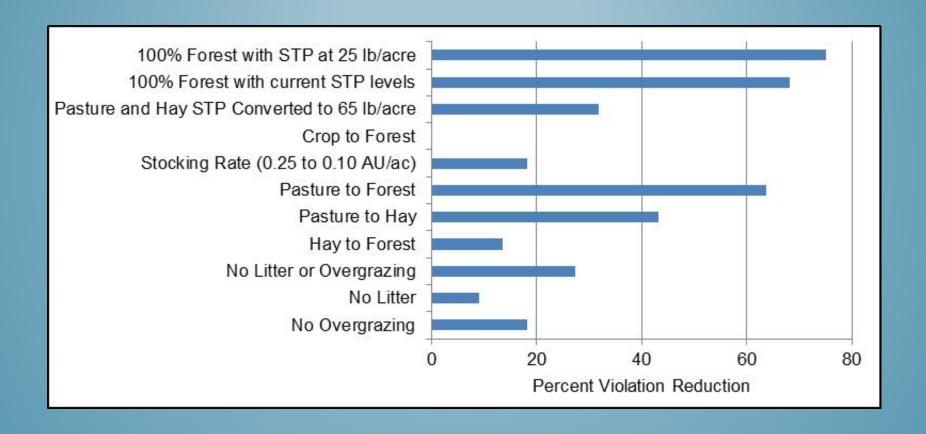
Lake Eucha P concentration from upper end of the lake (worst case)



#### **MANAGEMENT SCENARIOS ANALYZED**

- 100% litter export
- Converting all hay to forest
- Converting all pasture to hay or forest
- Reducing the stocking rate from 0.25 to 0.10 AU/acre
- Converting all crops to forest
- Reducing the STP levels to 65 lb ac<sup>-1</sup>
- Converting all land covers to forest and reducing STP levels to 25 lb ac<sup>-1</sup>

### MANAGEMENT SCENARIOS ANALYZED



## SCENARIOS TO MEET STANDARDS ILLINOIS RIVER WATERSHED

#### Scenario 1

- No litter
- No overgrazing
- 50% pasture to hay
- No urban P fertilizer

#### Scenario 3

- Convert all pasture and hay with slope > 10% to forest
- No litter application
- Reduce STP levels to 65 lb ac<sup>-1</sup>

#### > Scenario 2

- Reduce pasture/hay
   STP levels to 65 lb ac<sup>-1</sup>
- No litter application
- 25% of pasture converted to hay

#### Scenario 4

- 25% pasture and hay converted to forest
- Stocking rate decreased to 0.10 AU ac<sup>-1</sup> (Illinois only)

### SCENARIOS TO MEET STANDARDS IN EUCHA-SPAVINAW WATERSHED

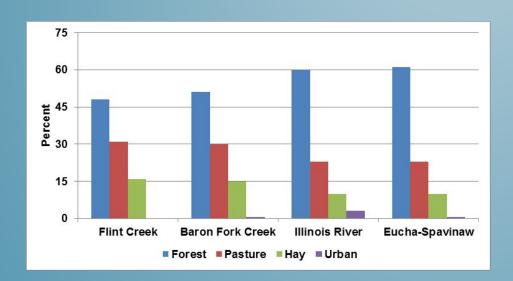
- > Scenario 1
- All pasture converted to hay

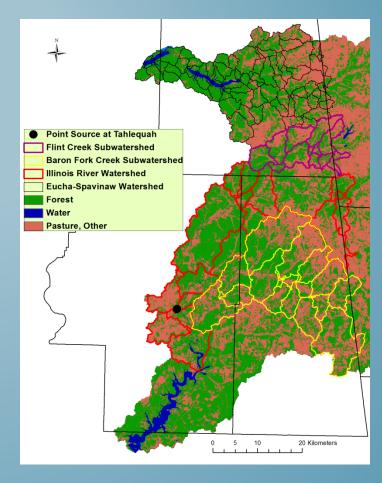
- > Scenario 3
- Pasture and hay STP converted to 65 lb ac<sup>-1</sup>
- No litter application

- Scenario 2
- No litter application
- All crops converted to forest
- Scenario 4
- No litter application
- 25% of pasture converted to forest

## REASONS FOR MEETING OR NOT MEETING WATER QUALITY STANDARDS

- Land cover
- Point sources
- Different water quality standards





#### **SUMMARY**

- 1. Positive changes have taken place in the last decade in both watersheds including 80-90% litter export and large reductions in phosphorus discharge from point sources
- 2. Multiple land use changes and/or best management practices need to be implemented in the Illinois River watershed for Oklahoma to meet phosphorus standard
- 3. Based on averaged weighted phosphorus concentration, Oklahoma is meeting the Lake Eucha phosphorus standard