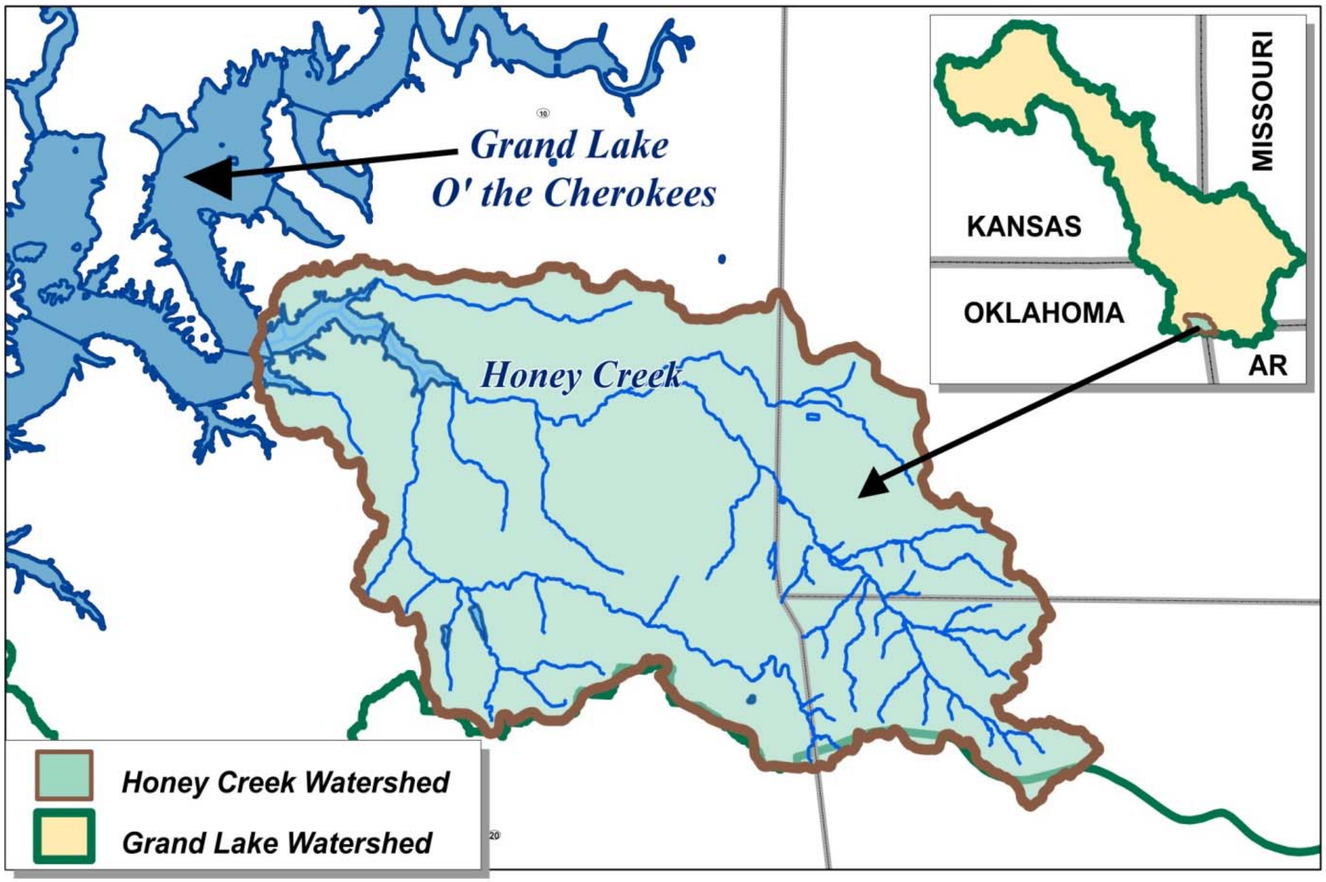
Initial Results of Paired Watershed Analysis for Honey Creek

OKLAHOMA CONSERVATION COMMISSION

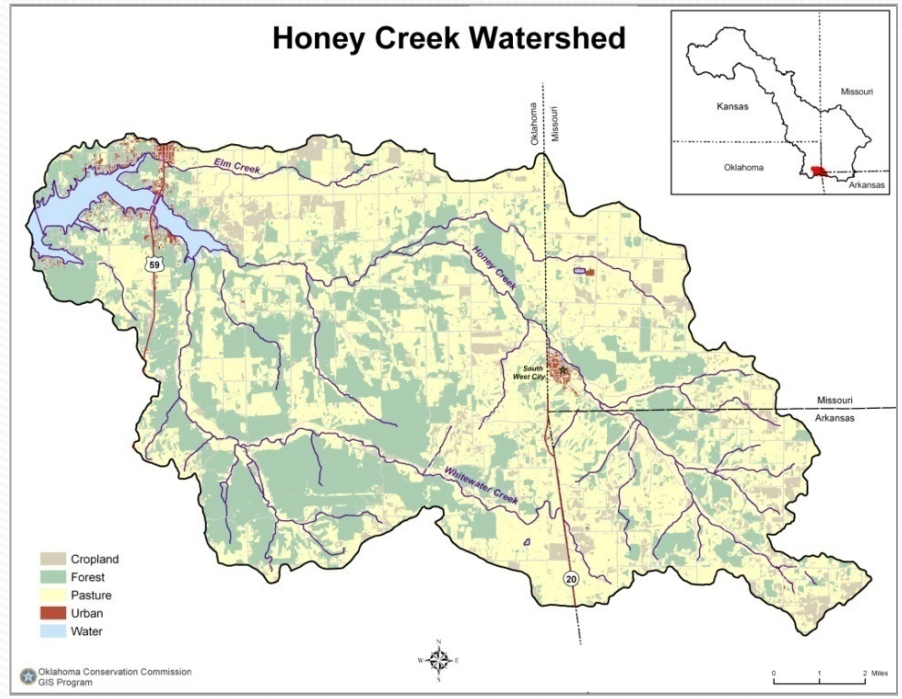
- Honey Creek is a tributary to Grand Lake in northwestern Oklahoma
- 78,000 acre watershed in 3 states (70% in OK)



Landuse in Honey Cr. Watershed

- **57% pastureland**

  (78% of stream miles run through pastureland)
- **33% forest**
- **7% cropland**



Approximately **1.5 million chickens** produced each year in Delaware Co. (2010 AG Census)

Background

- **1995:** Clean Lakes Study showed **excess phosphorus** in Grand Lake was contributing to **low dissolved oxygen** and **algal blooms**
- **2000:** USGS study revealed **fecal bacteria** in both surface and groundwater of Honey Creek Watershed; sources mostly from horses and cattle, but human traces seen as well
- **2002:** OWRB Beneficial Use Monitoring Program Report indicates that Grand Lake is hypereutrophic, with **high turbidity** and **high chlorophyll-*a*** values

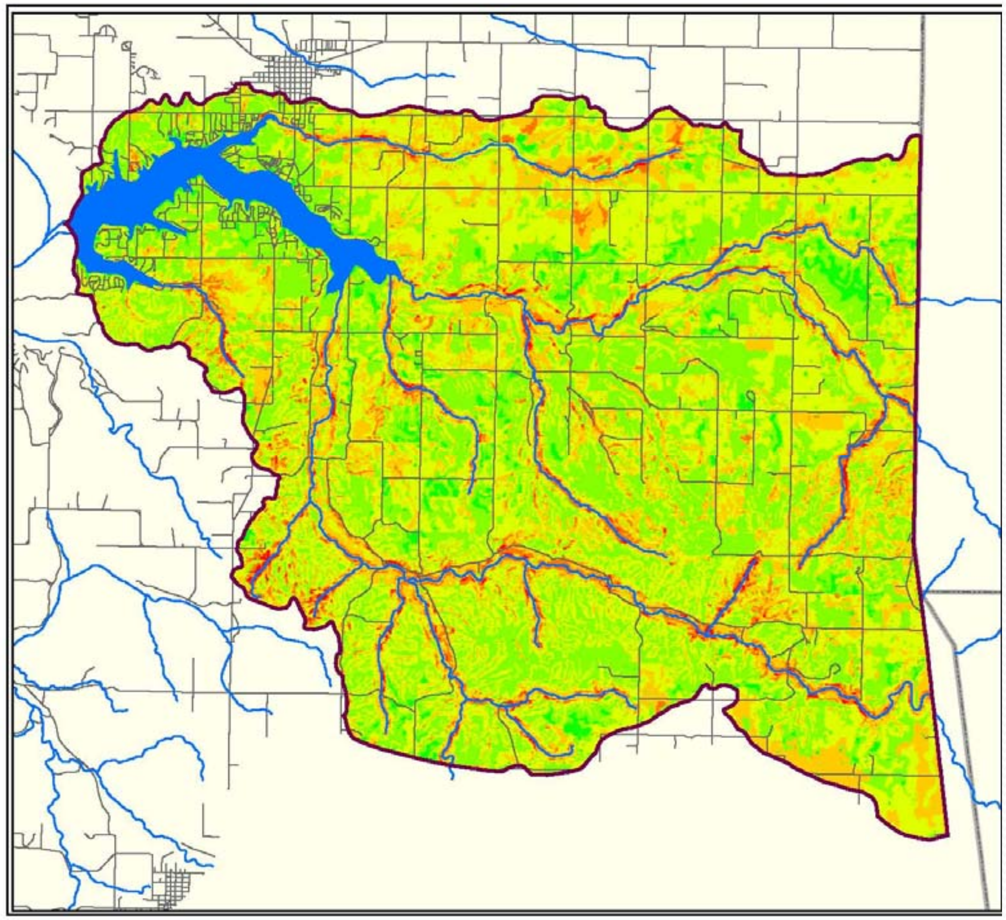


Background, *continued*

- **2002:** Grand Lake and several streams in the watershed are placed on 303(d) list; impairments include pathogens, low DO, sulfate, TDS, and chloride
- **2006:** OCC begins implementation project in Honey Creek Watershed
- **2007:** OCC initiates the creat
Farm in the watershed

BMP Implementation Project

- Targeted implementation based on SWAT model which showed areas of highest potential phosphorus loading
- Approx. 50% of P load comes from 27% of watershed



BMP Implementation Project

- Worked through Delaware County Conservation District in cooperation with local NRCS
- Hired local staff to lead project

- Convened a Watershed Advisory Gr start of project to suggest BMPs, cost-sha prioritization of practices
- Began upstream-downstream moni ey Creek to assess effects of BMP implementation

BMP Implementation

- Riparian Area Establishment and Management
  - Over 400 acres protected with over 40,300 linear feet of fence

Before

After

BMP Implementation

- Alternative Water Supplies
  - 167 tanks and 24 ponds

Ponds

Tanks

BMP Implementation

- Animal Waste Storage/Feeding Facilities
  - 27 facilities

BMP Implementation

- Pasture Establishment and Management
  - 146 acres of pasture planting (bermuda or fescue)
  - Over 235,000 linear feet of cross-fencing

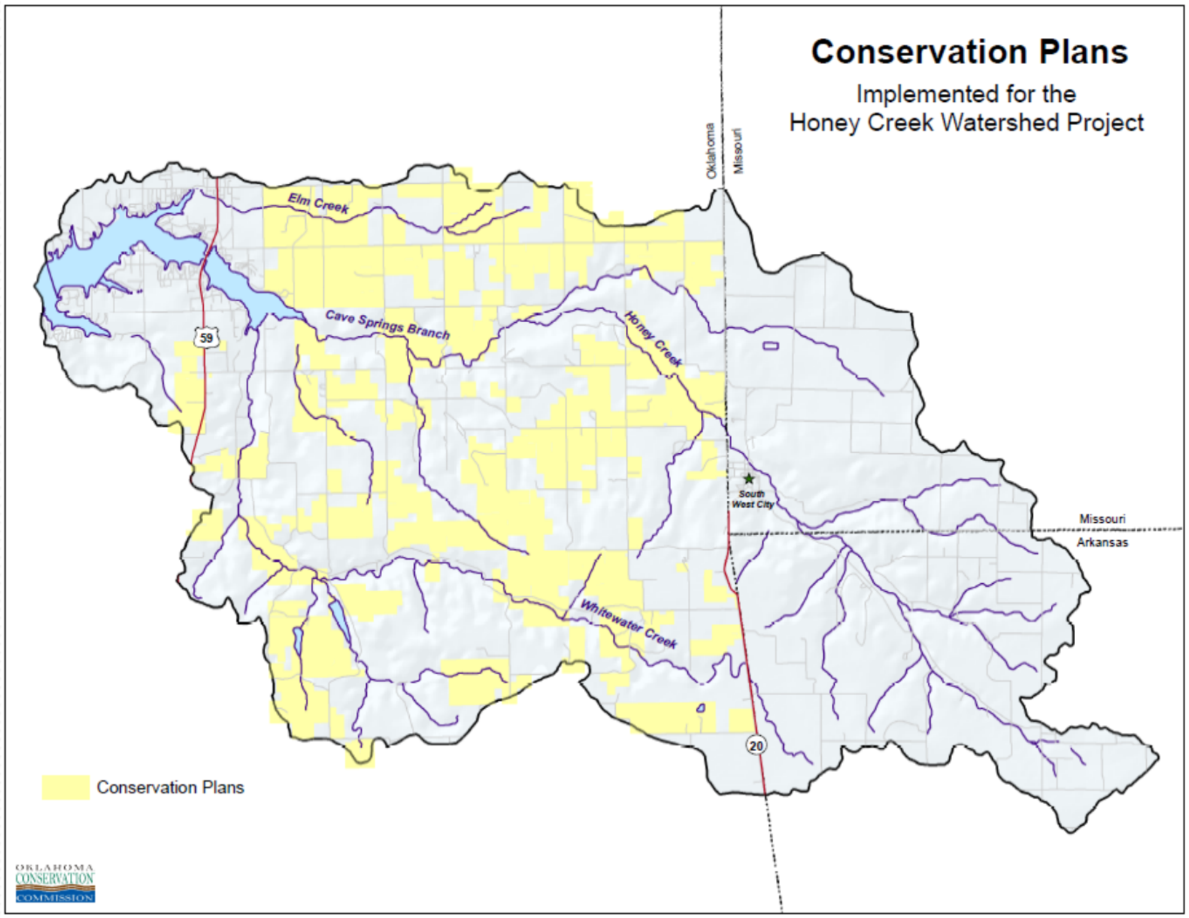
Before

After

BMP Implementation

- Heavy use area protection
  - 173 areas with geotextile, concrete, and/or gravel

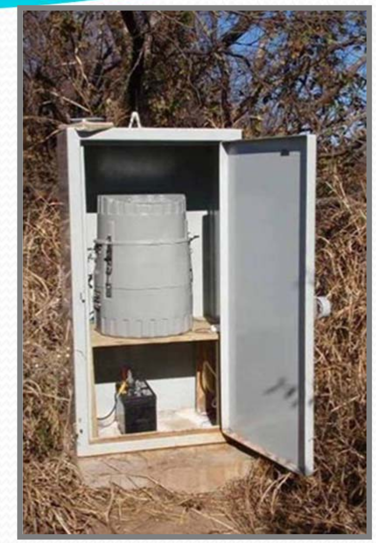
As of 2011, nearly 50% of watershed participating in BMP implementation, with 42% of high P yield zones included in BMP areas



Monitoring Design

- Nested watershed:
  HC Upper (control)
  HC Lower (treatment)
- Began weekly monitoring in April 2007

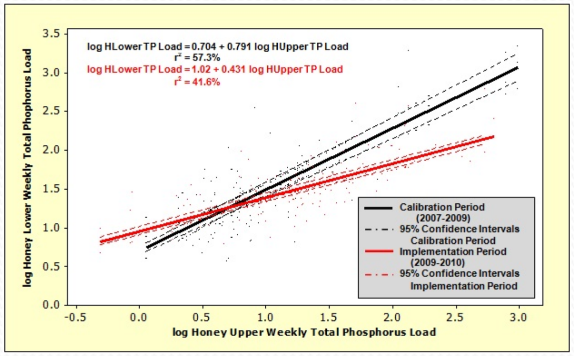
Monitoring Design



- Continuous, flow-weighted composite sampling
  - TotPhos, orthoPhos, nitrate, ammonia, TKN
  - Weekly and after storm events
- Field parameters (weekly)
  - DO, pH, temp, turbidity, conductivity, hardness, alkalinity, flow
- Weekly grabs for bacteria (May – September)
- Monthly grabs for TSSolids, chloride, sulfate

Data Analysis: Paired Watershed Method

- <u>Two watersheds</u>:
  Control (no BMPs) = upstream
  Treatment (BMPs installed) = downstream
- <u>Two periods of study</u>:
  Calibration (pre-BMP installation): April 2007 – April 2009
  Treatment (during or post-implementation): May 2009 – June 2010
- Calculate weekly loads for each parameter (conc * tot wkly flow)
- Establish relationship between watersheds for each period (log-linear regression of weekly loads for each parameter)

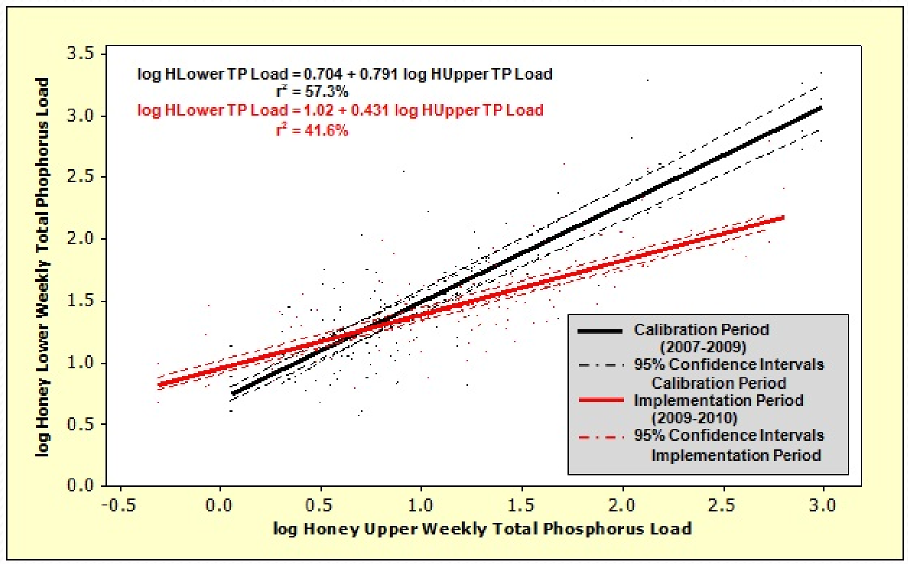


Data Analysis: Paired Watershed Method

- Perform ANCOVA to analyze difference between periods while accounting for environmental effects
- Determine load reductions by comparing “expected” loads to “monitored” loads during treatment period

Expected loads are modeled loads based upon the calibration period relationship

(indicates what the loads should be in the treatment watershed if nothing changed from calibration period)

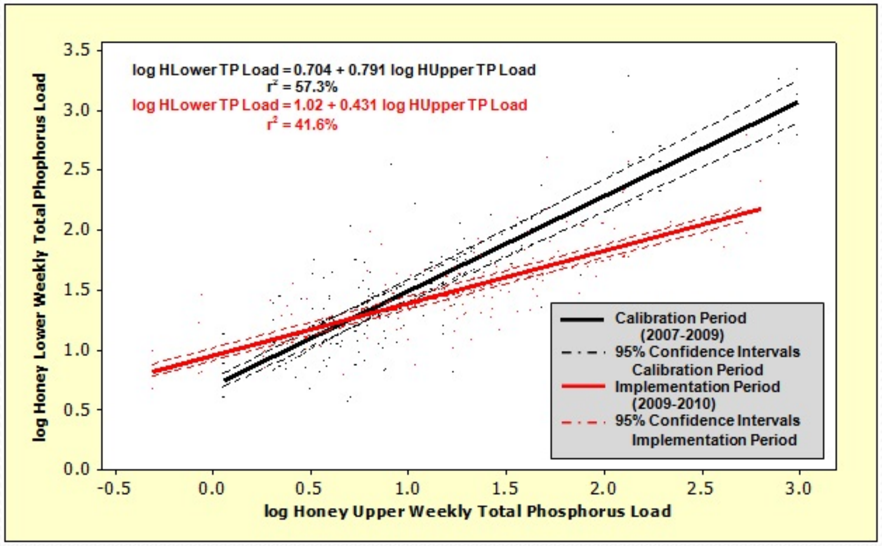


Preliminary Results

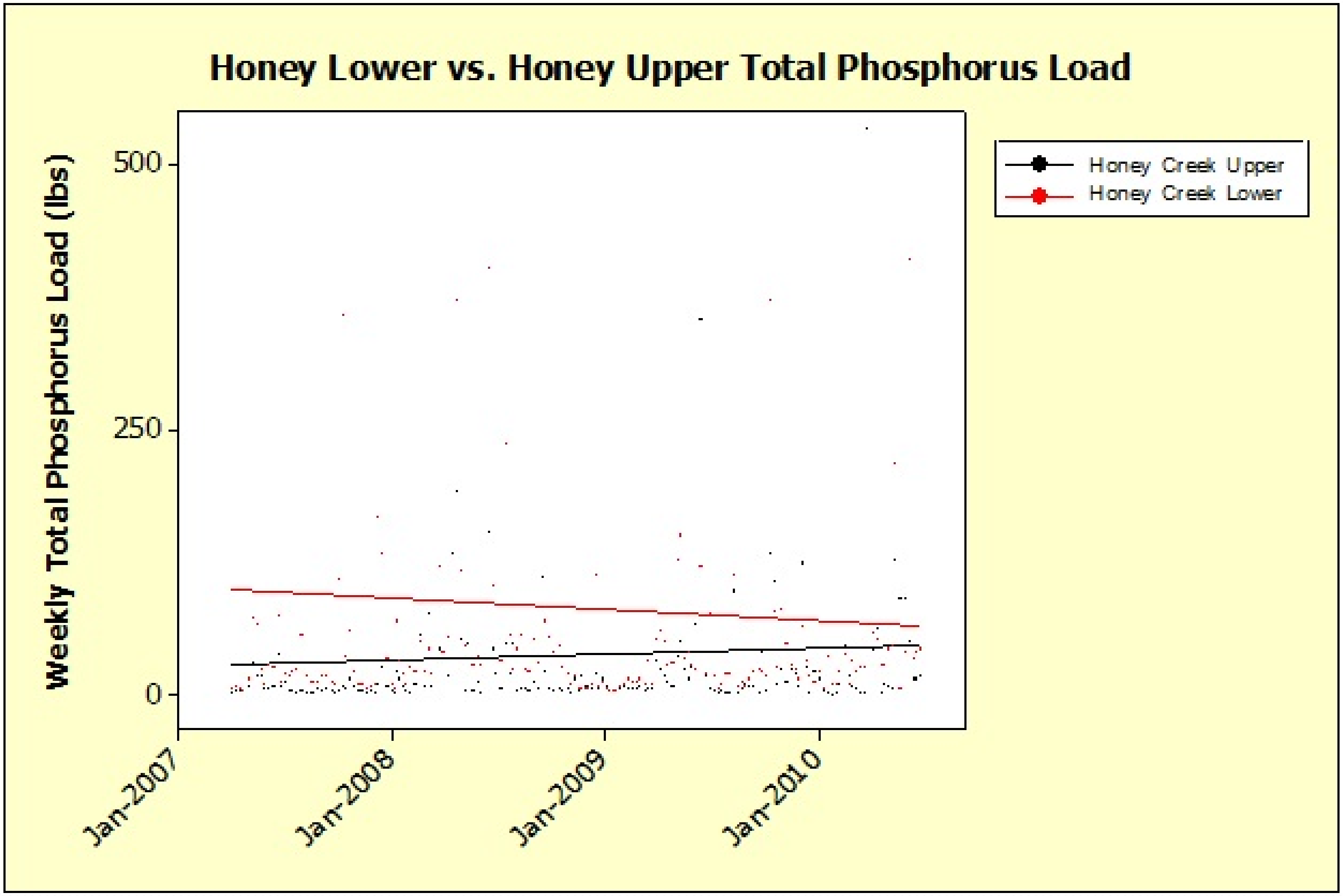
Total Phosphorus Load

	Avg Weekly Load (lbs)
Calibration Period	
HC Upper (monitored)	**33.6**
HC Lower (monitored)	**96.3**
Treatment Period	
HC Upper (monitored)	**39.5**
HC Lower (monitored)	**59.1**
HC Lower (modeled)	**78.3**
Change in TP Load (monitored vs. modeled)	**-24.5%**

Significantly different slopes and intercepts



Least Squares Means Method: 15% reduction in TP load



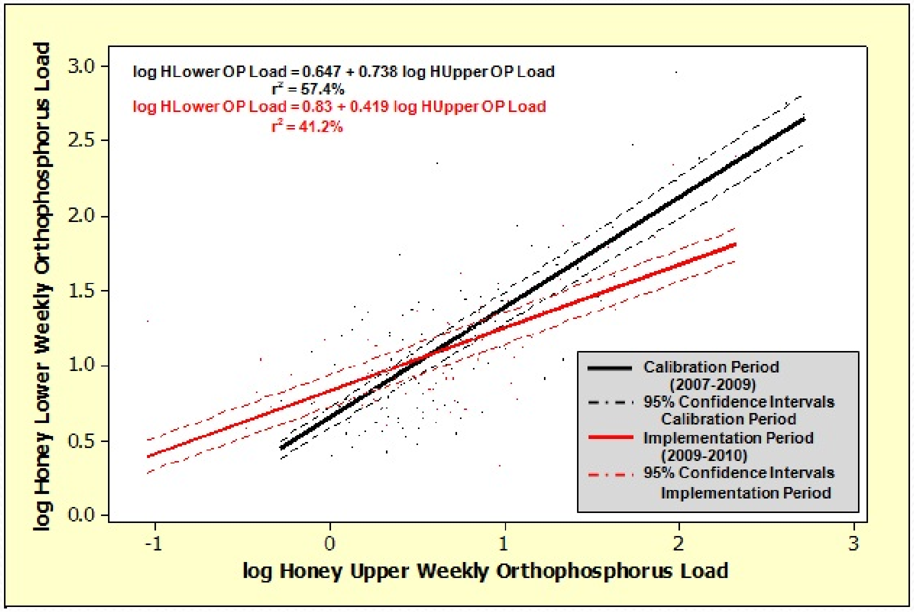
Neither regression is statistically significant (p<0.10)

Preliminary Results

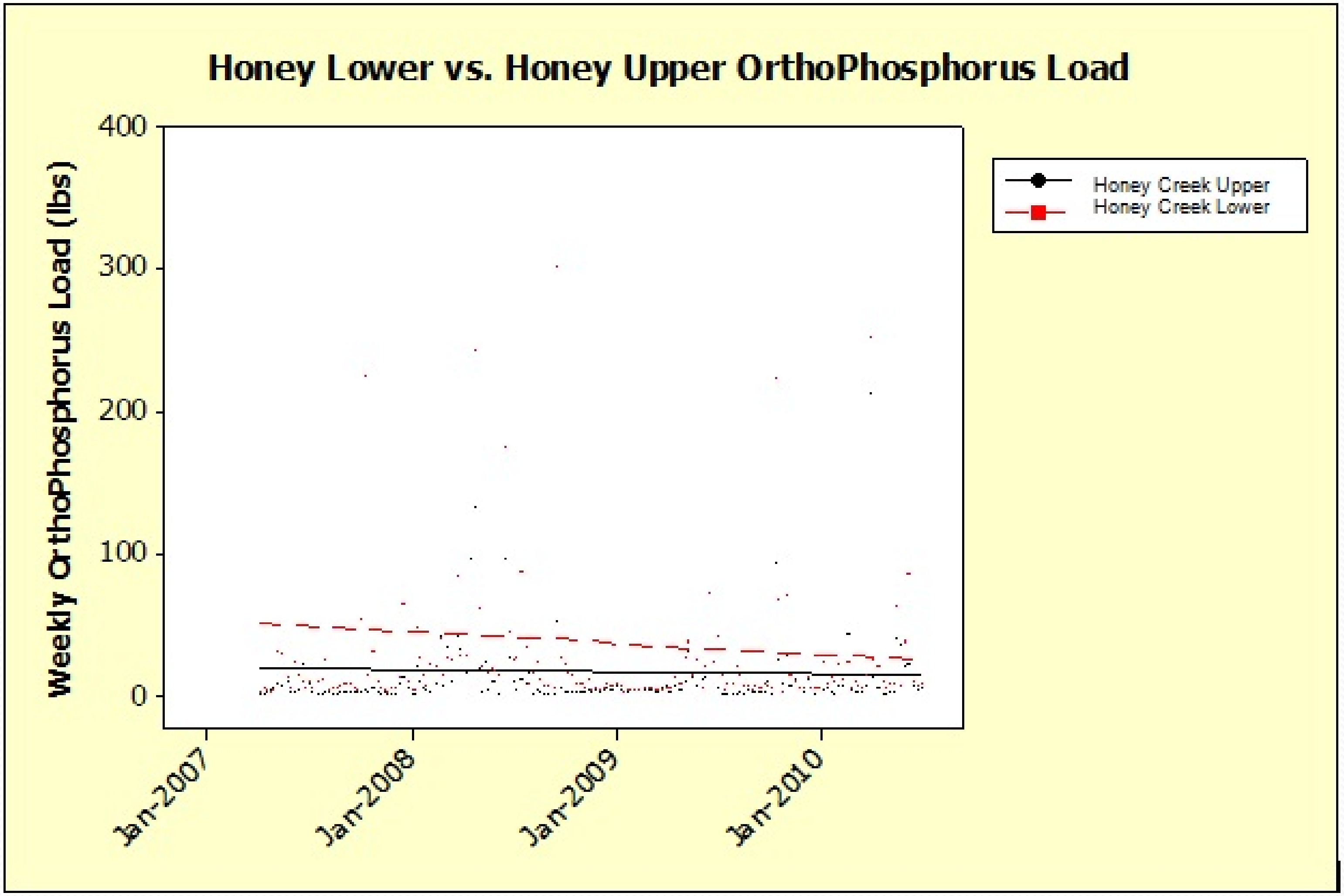
Ortho-Phosphorus Load

	Avg Weekly Load (lbs)
Calibration Period	
HC Upper (monitored)	18.4
HC Lower (monitored)	46.2
Treatment Period	
HC Upper (monitored)	13.7
HC Lower (monitored)	23.9
HC Lower (modeled)	24.9
% difference (monitored vs. modeled)	-4.0%

Significantly different slopes and intercepts



Least Squares Means Method: 7% reduction in oP load

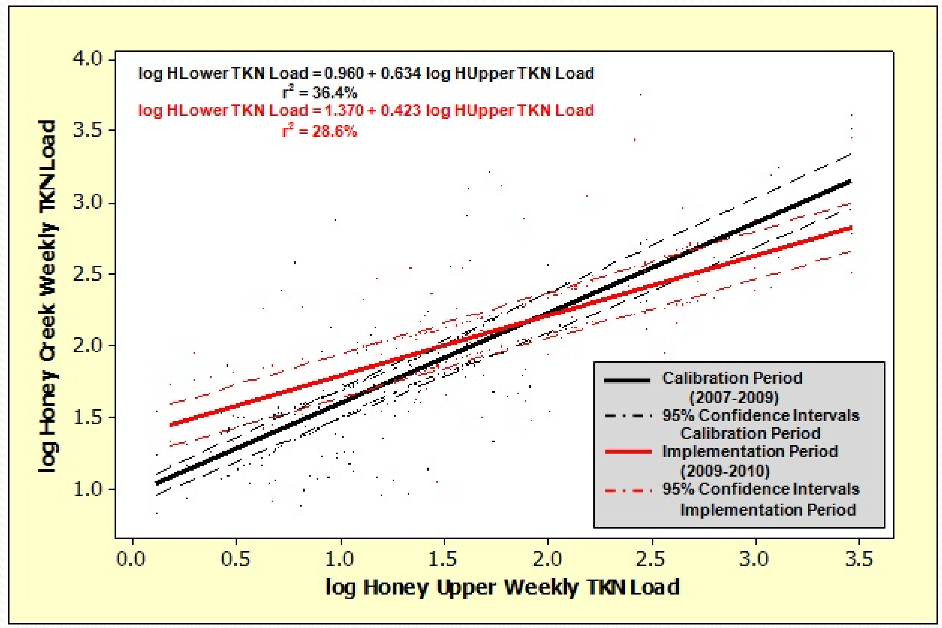


Neither regression is statistically significant (p<0.10)

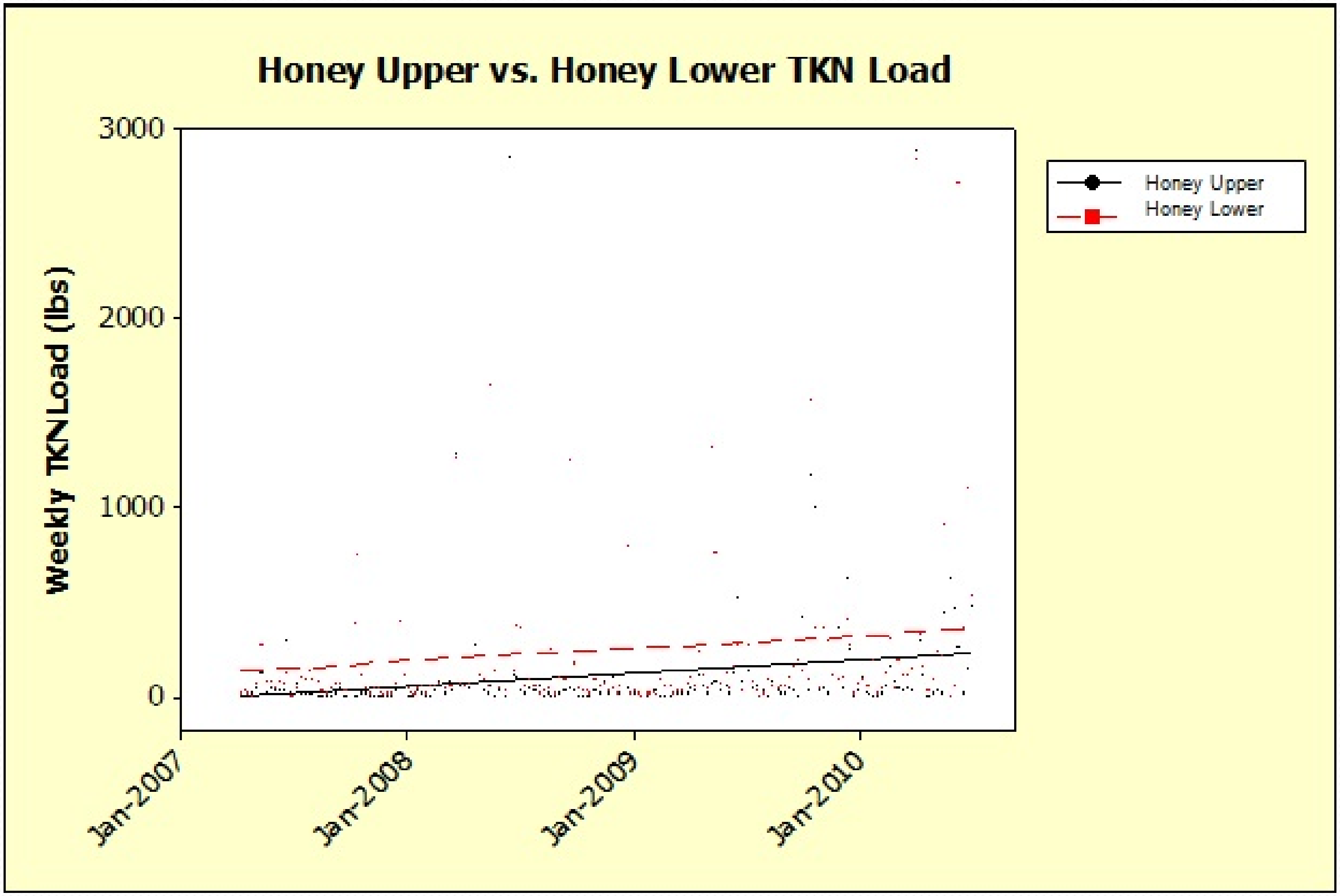
Preliminary Results

Total Kjeldahl Nitrogen Load

	Avg Weekly Load (lbs)
Calibration Period	
HC Upper (monitored)	67.5
HC Lower (monitored)	209.1
Treatment Period	
HC Upper (monitored)	185.8
HC Lower (monitored)	295.8
HC Lower (modeled)	189.5
% difference (monitored vs. modeled)	56.1%



Least Squares Means Method: 24% gain in TKN load

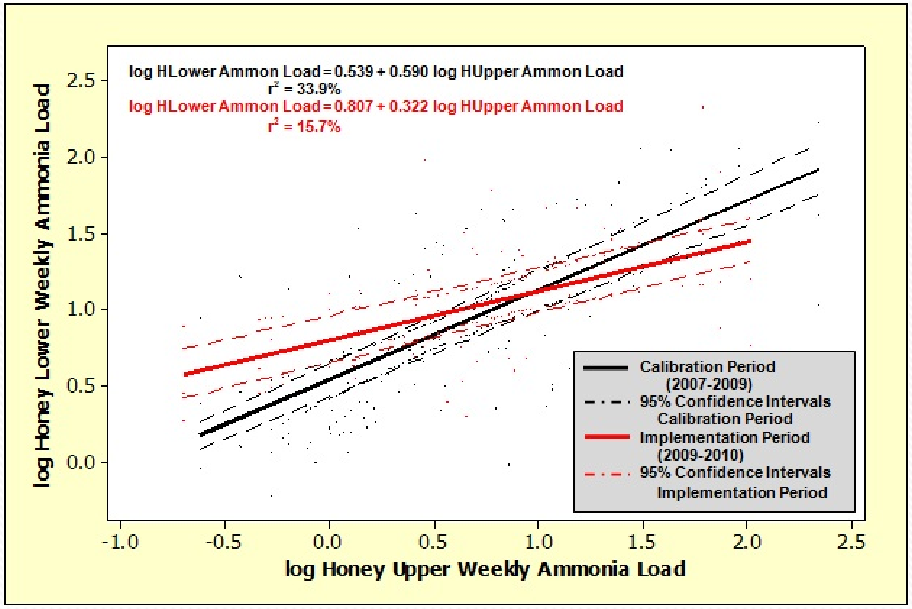


Honey Upper regression is statistically significant (p=0.02)

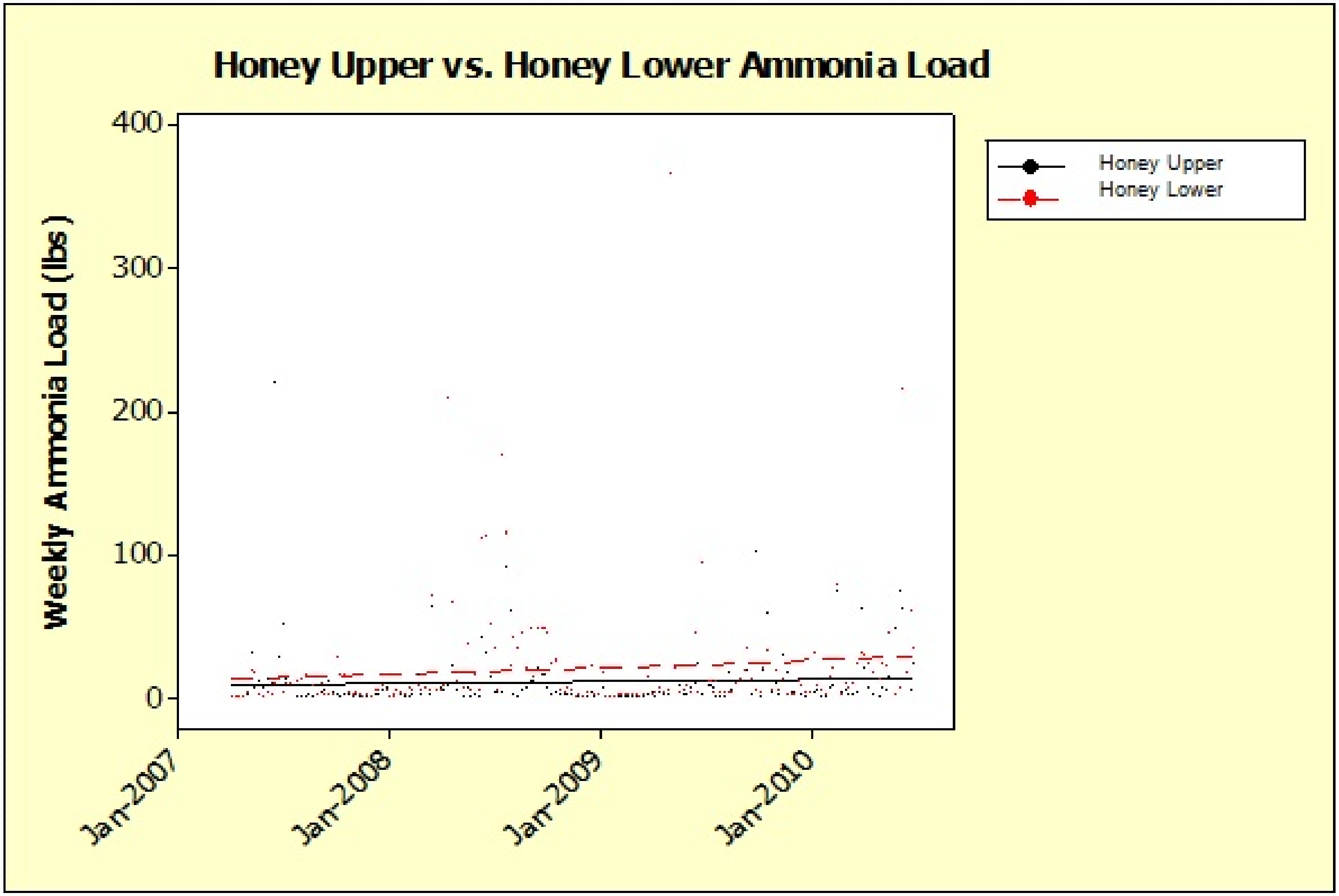
Preliminary Results

Ammonia Load

	<u>Avg Weekly Load (lbs)</u>
<u>Calibration Period</u>	
HC Upper (monitored)	**9.9**
HC Lower (monitored)	**18.4**
<u>Treatment Period</u>	
HC Upper (monitored)	**14.8**
HC Lower (monitored)	**25.2**
HC Lower (modeled)	**14.7**
% difference (monitored vs. modeled)	**71.4%**



Least Squares Means Method: 8.5% gain in ammonia load

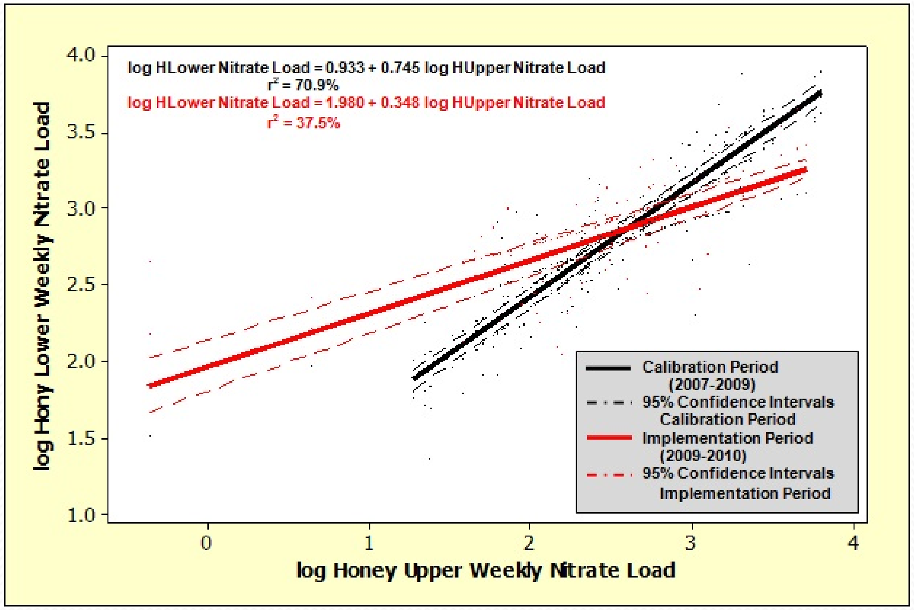


Neither regression is statistically significant ($p<0.10$)

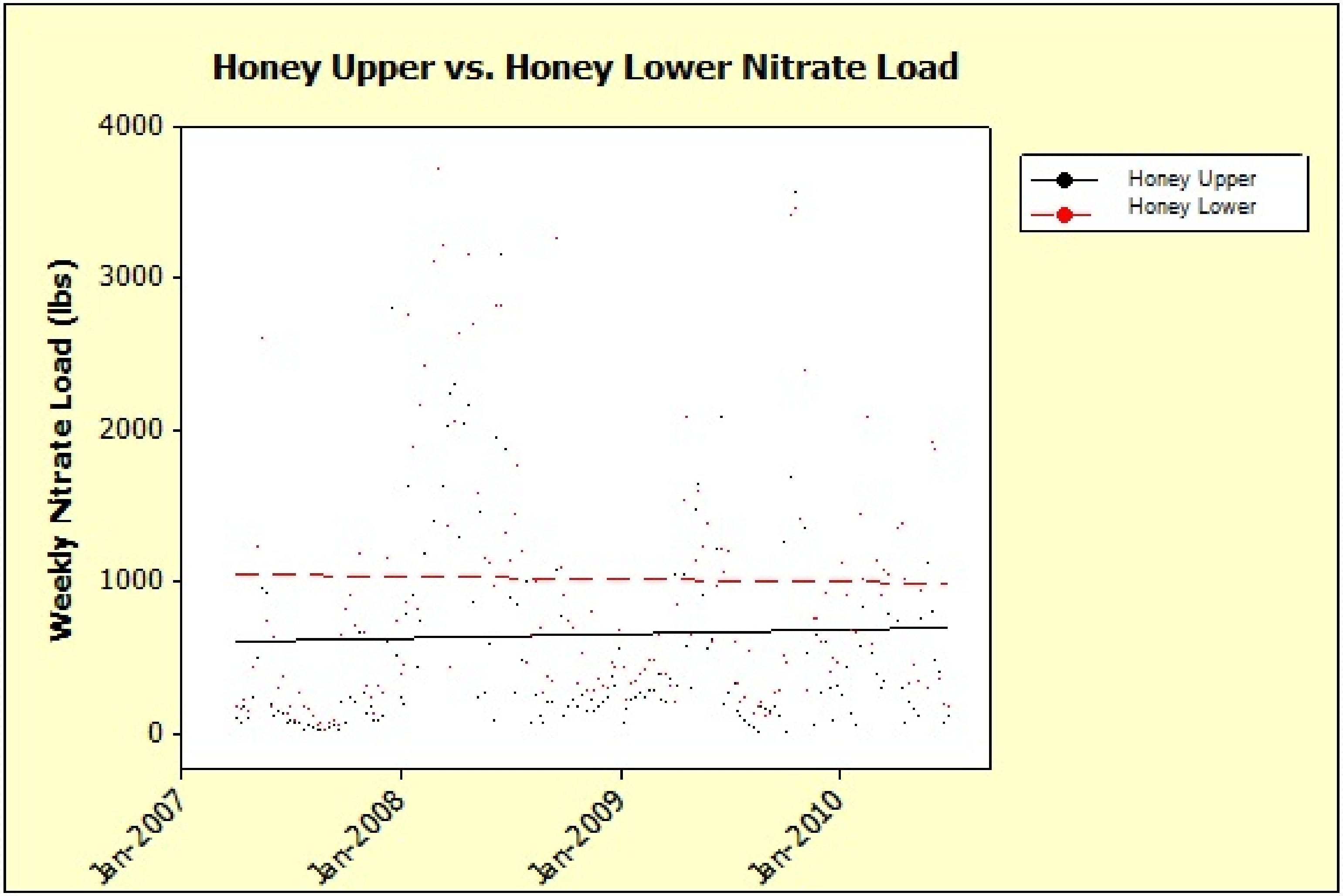
Preliminary Results

Nitrate Load

	Avg Weekly Load (lbs)
Calibration Period	
HC Upper (monitored)	**670**
HC Lower (monitored)	**968**
Treatment Period	
HC Upper (monitored)	**637**
HC Lower (monitored)	**1046**
HC Lower (modeled)	**966**
% difference (monitored vs. modeled)	**8.3%**



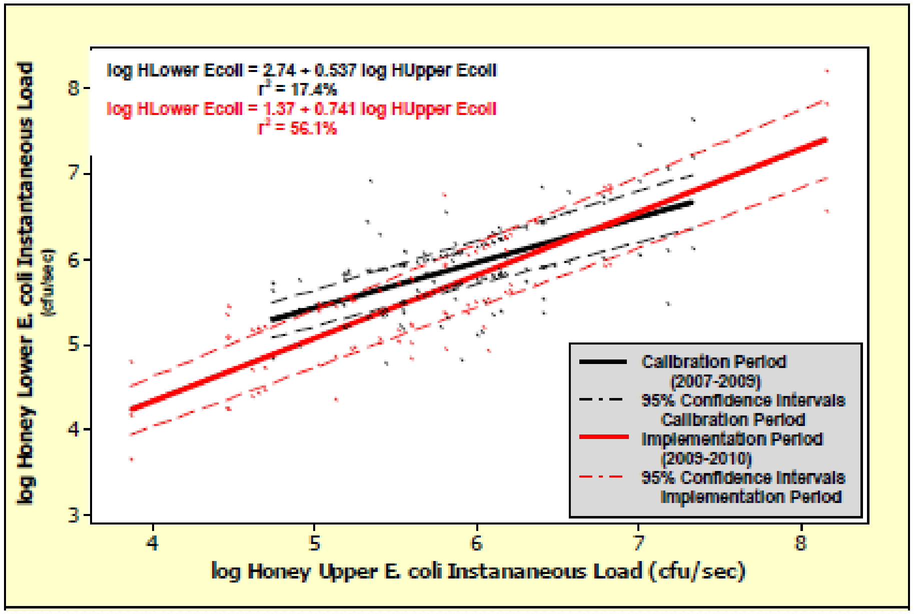
Least Squares Means Method: 2.2% gain in nitrate load



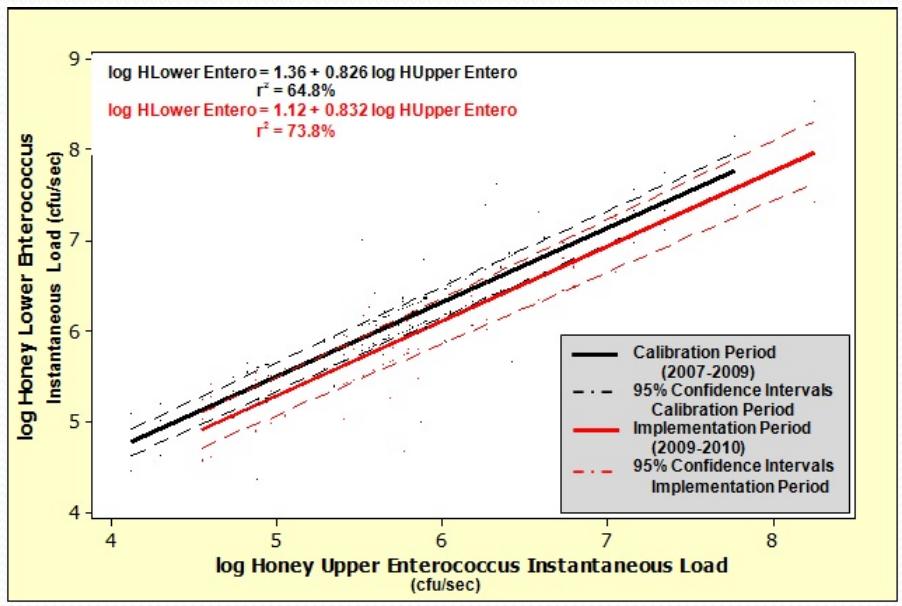
Neither regression is statistically significant ($p<0.10$)

Bacteria Load: cfu/100 ml * instantaneous discharge

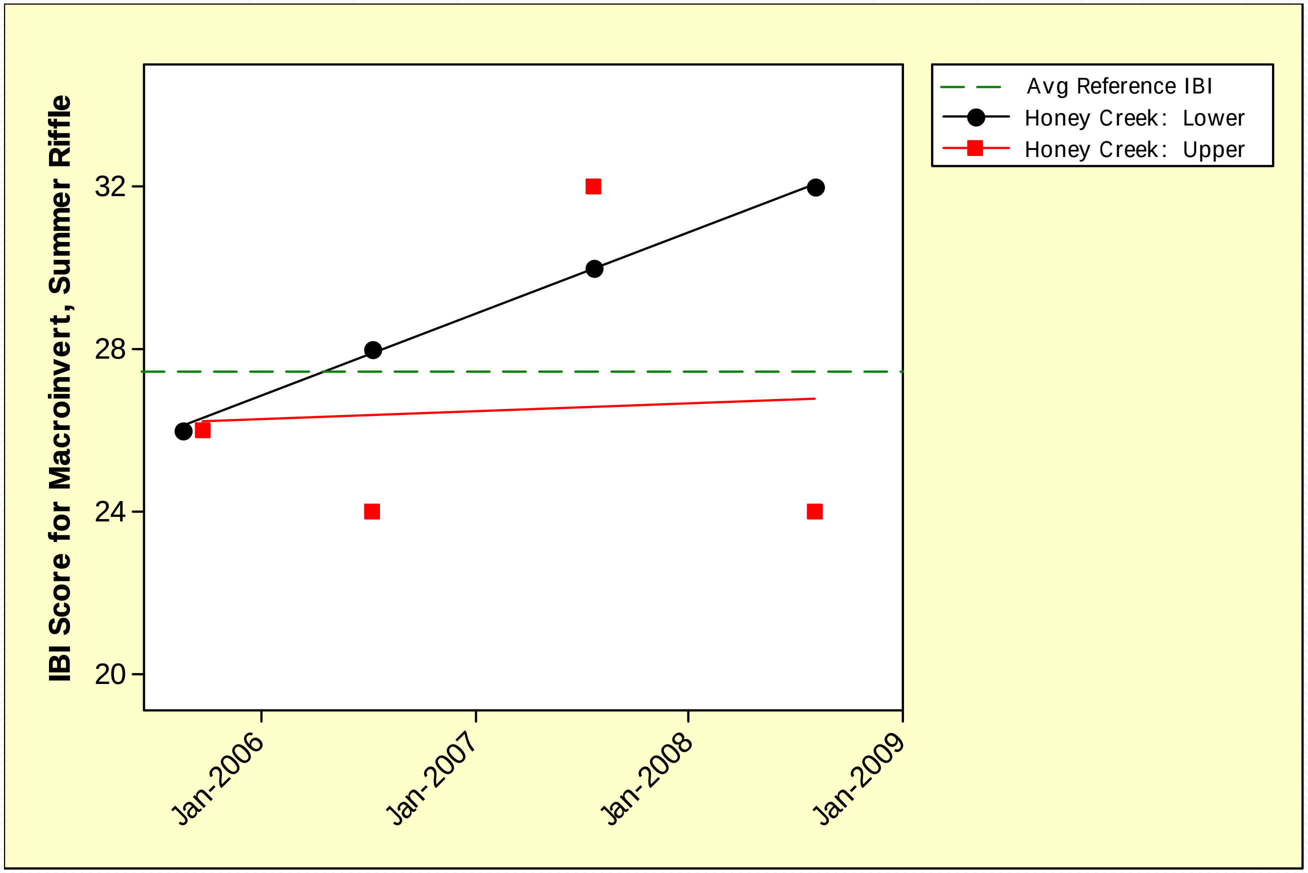
E. coli – 35% reduction from expected



Enterococcus – 38% reduction from expected



Macroinvertebrate Collections



Average Concentrations and Loads by Period

	Parameter	Honey Lower Calib	Honey Lower Implem.	Honey Lower Change	Honey Upper Calib	Honey Upper Implem	Honey Upper Change
Concentration (mg/L)	TotPhosphorus	0.1417	0.1244	⇓	0.0837	0.1139	⇑ *(0.084)
	Ortho-Phosphorus	0.0648	0.0465	⇓ *(0.072)	0.0431	0.0349	⇓
	Ammonia	0.0413	0.0603	⇑ *(0.093)	0.0659	0.0529	⇓
	Nitrate	2.3150	2.2205	⇓	2.3170	1.9812	⇓ *(0.078)
	TKN	0.3403	0.5974	⇑ **(0.007)	0.1992	0.5211	⇑ **(0.000)
Load (lbs)	TotPhosphorus	96.30	59.11	⇓	33.60	39.50	⇑
	Ortho-Phosphorus	46.20	23.99	⇓	18.43	13.67	⇓
	Ammonia	18.40	25.15	⇑	9.97	14.78	⇑
	Nitrate	968	1046	⇑	670	637	⇓
	TKN	209.1	295.8	⇑	67.5	185.8	⇑ **(0.032)

Education Component

- Demonstration farm

- Producer education events

- Youth education

Summary of Prelim Results

- $1.7 million dollars spent on BMP implementation
- Nearly 50% of watershed participating on some scale
- Reduced TP load and bacteria loads significantly from expected loads
- Nitrogen parameters showed no change or increases (could be due to poultry operation at border)
- Steady increase in macroinvertebrate health
- Continued public participation and interest

What's next?

- Implementation continues through December 2013
- Analysis will be redone with additional 2 years of data
- Hopefully, will see further reductions in nutrients and eventual improvement in lake

OKLAHOMA CONSERVATION COMMISSION

NRCS Natural Resources Conservation Service

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY