
Water quality trends in a CEAP watershed

E.E. Gbur¹
I. Chaubey²
M. W. Gitau³
J. H. Pennington¹

CEAP Project No. 2005-48619-03334

¹ University of Arkansas

² Purdue University

³ Florida A&M University

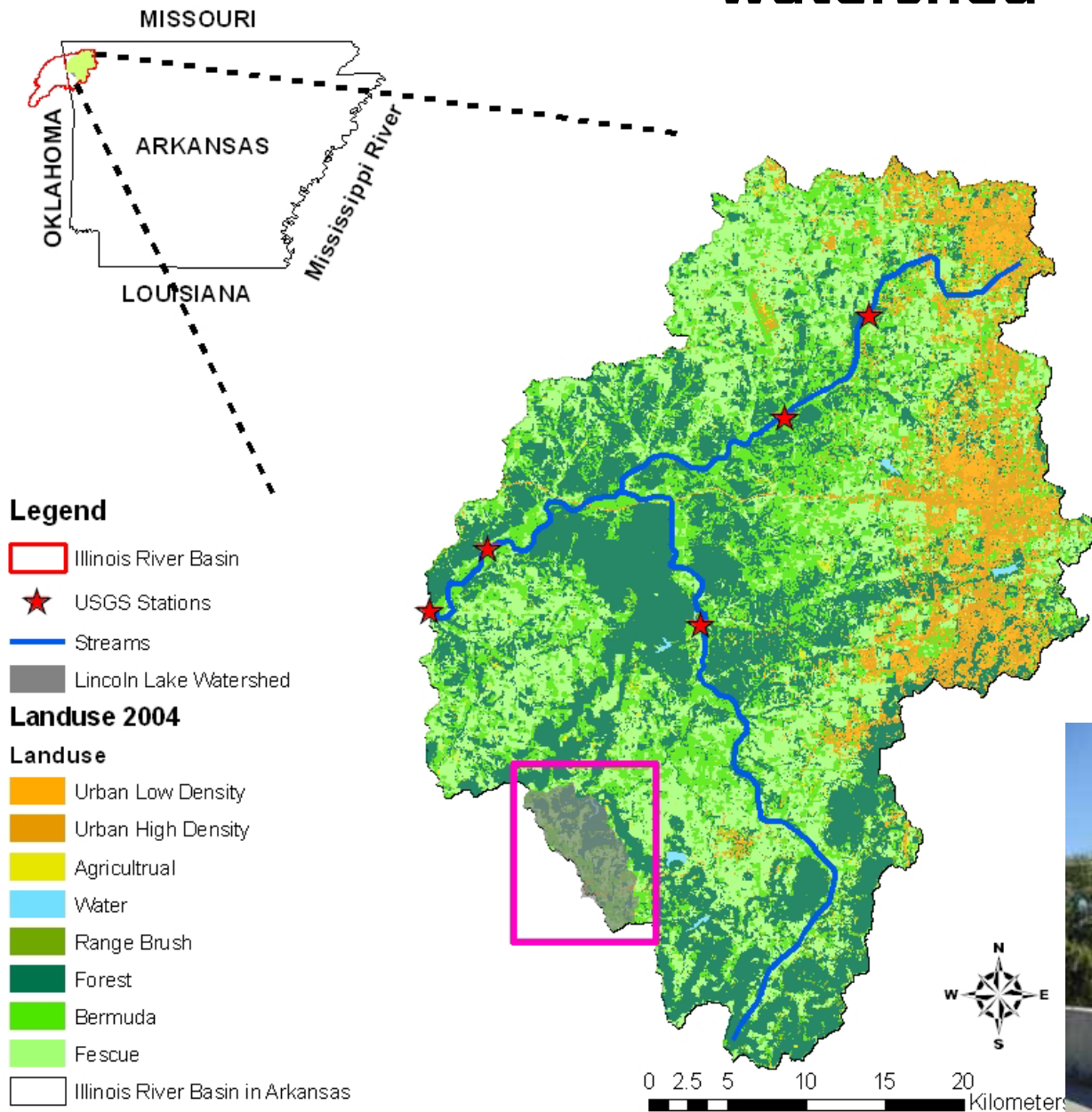


PURDUE UNIVERSITY
AGRICULTURAL AND BIOLOGICAL ENGINEERING

U of A
UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE



Study Area: Illinois River Basin & Lincoln Lake watershed



□ Area: 1467 km²

□ 5 USGS gauging stations

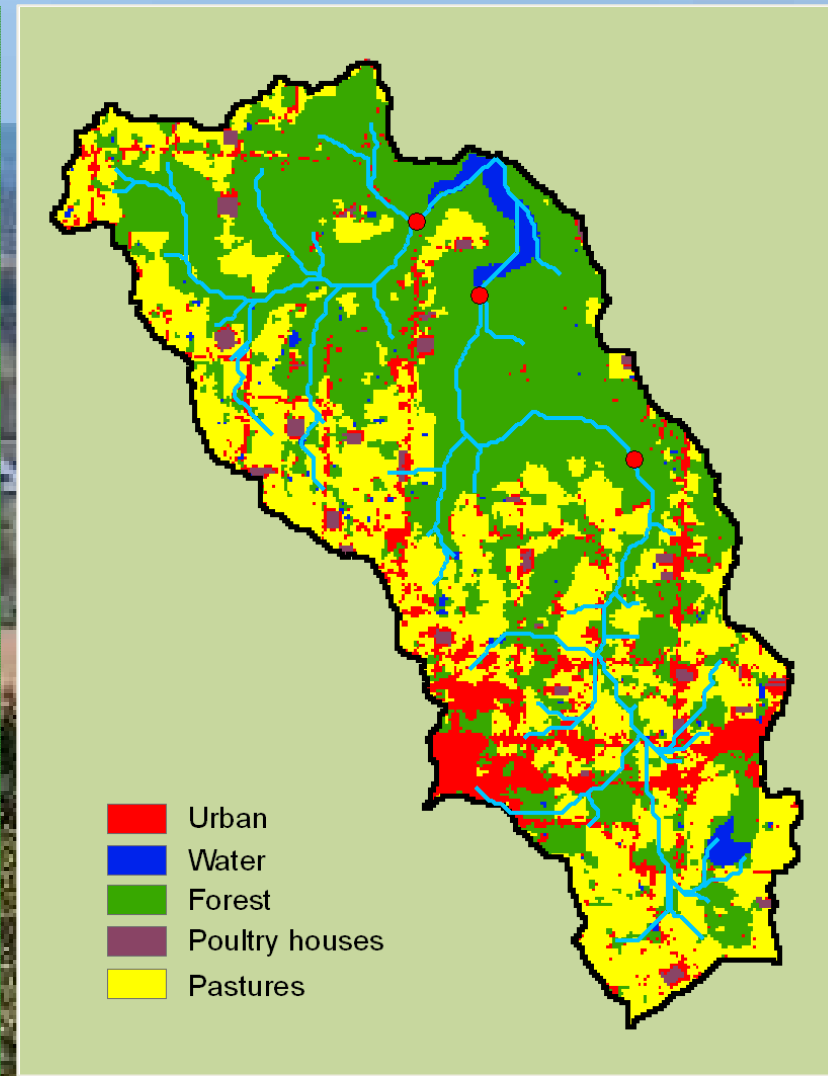
□ Land use:

- Pasture 50%
- Forest 38%
- Urban 11%



Lincoln Lake watershed

- Tributary of Illinois River
- Size - 32 km²
- Land use
 - Pasture 36%
 - Forest 39%
 - Urban 12%
- Primary concern – phosphorus from land application of animal manure



Land Use Trends

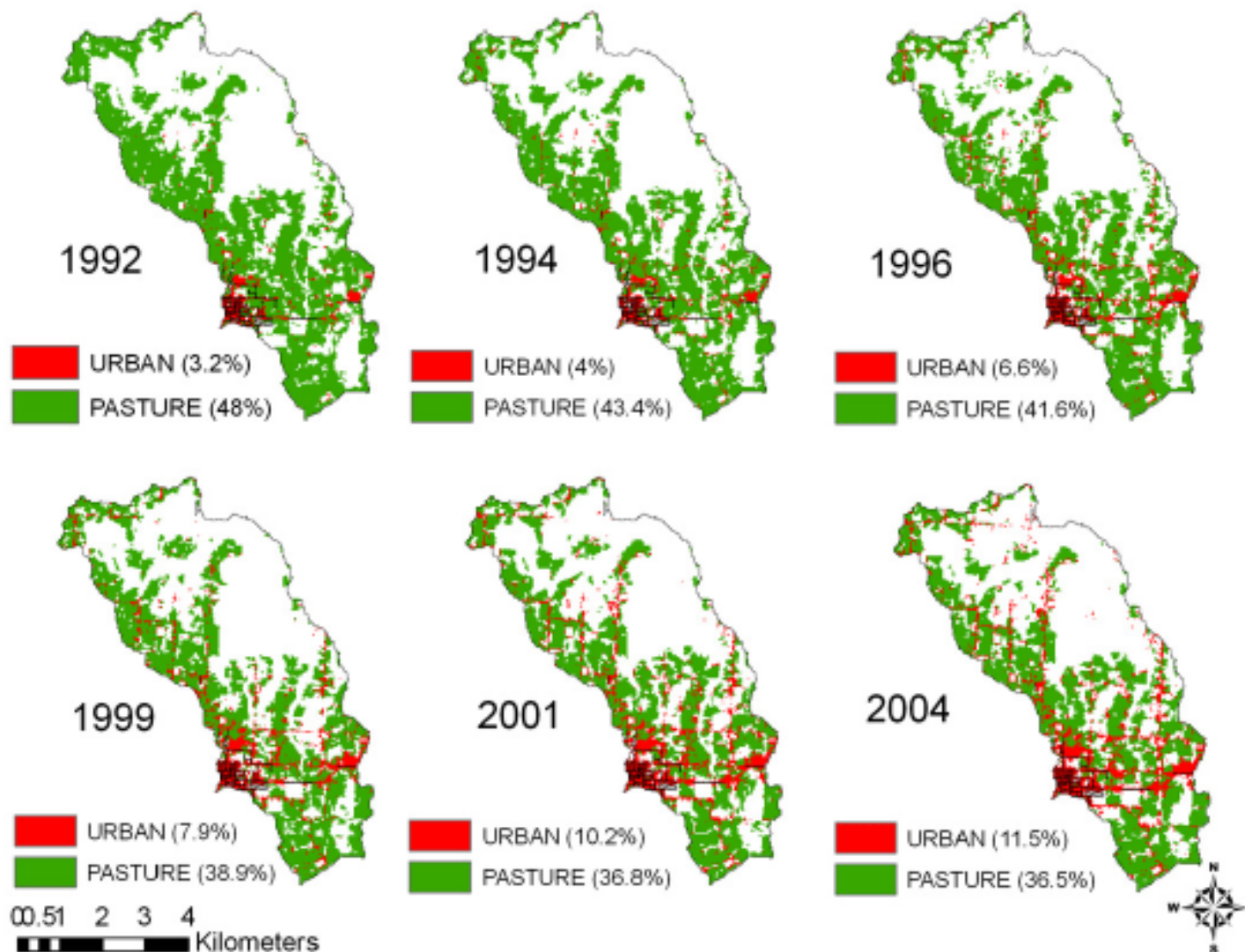
Historical Land Use Distribution (Percentage of watershed area)

Land use	Year					
	1992	1994	1996	1999	2001	2004
Urban	3	4	7	8	10	12
Pasture	48	43	42	39	37	37
Forest	39	44	40	37	45	39
Poultry	1	1	1	1	1	2
Transitional [†]	7	7	9	14	5	10

[†] Newly cleared forests and abandoned pastures



Land Use Change (1992 – 2004)



Conclusions

- Urban areas increased approximately four fold over the 12 year period from 1992 to 2004 and continue to do so. This parallels overall growth in Northwest Arkansas.
- The majority of the increase in urbanization has been in the southern two-fifths of the watershed. This area corresponds roughly to what will be called the Upper Moores Creek sub-watershed.
- Pasture areas have decreased steadily over time.
- Forest and transitional areas have become more variable in the last ten years.

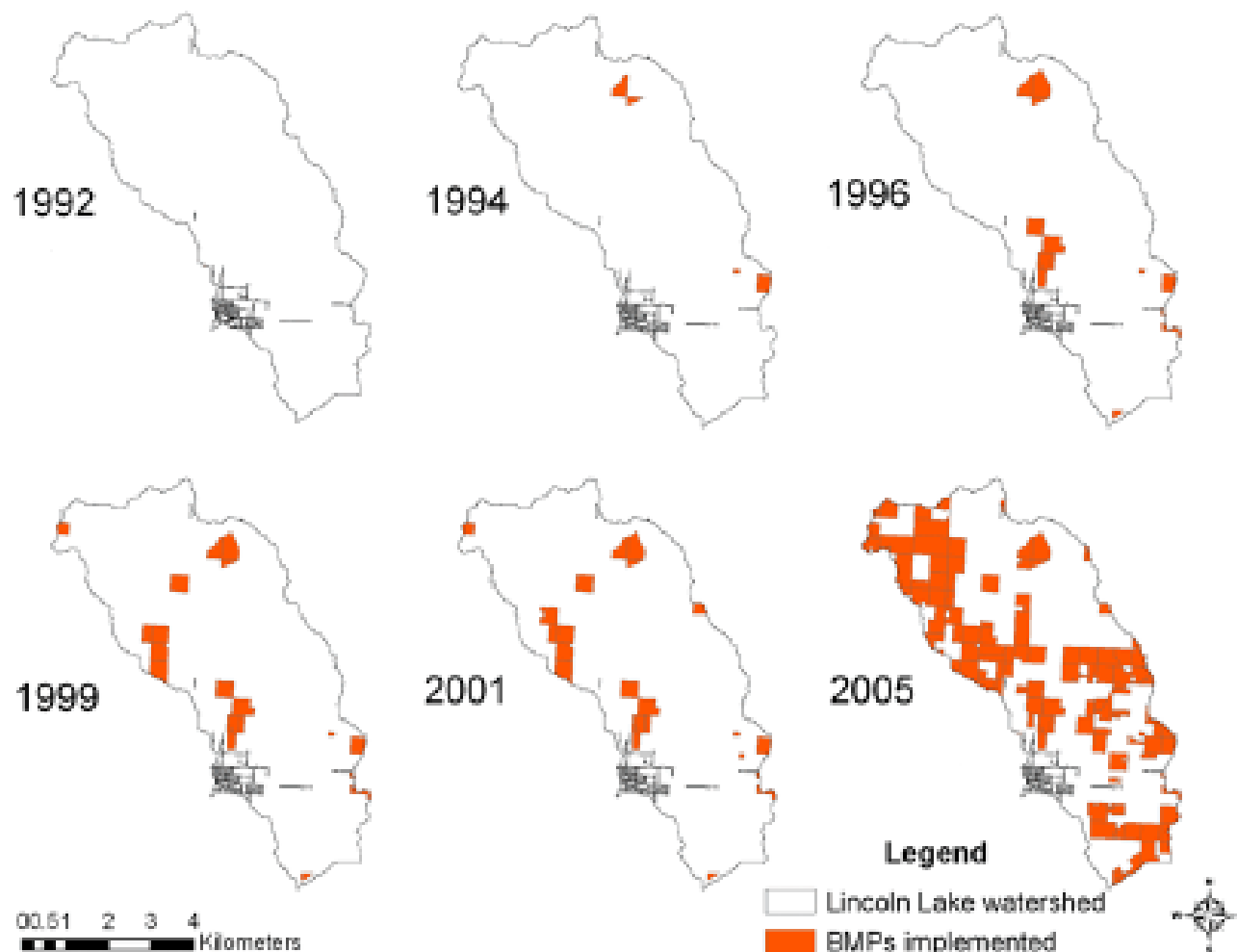


BMP Implementation

- **BMPs used in the watershed are primarily for pasture areas.**
- **Commonly used BMPs include:**
 - soil testing
 - use of litter instead of commercial fertilizer
 - litter application based on soil test results
 - reduced litter application
 - use of legumes to reduce nitrogen applications
 - rotational or controlled grazing
- **Other less commonly used BMPs include:**
 - use of litter amendments such as alum
 - use of litter storage sheds
 - filter strips and riparian areas
 - stream fencing



Best Management Practice (BMP) Areas (1992 – 2005)



- A survey of producers in the watershed was carried out in late Fall 2006 through early 2007. Sixty-two of 75 producers (82.7%) participated during meetings held in the watershed or through follow-up mailings.
 - 38.7% said that they had a NMP on file with NRCS.
 - 48.4% said that they or someone else had adopted at least one **BMP** on land that they owned or rented in the previous three years.
- Unfortunately, there is no guarantee that having an NMP on file means that a **BMP** other than soil sampling has actually been implemented.



Pre-existing and New NMPs Associated with the Project

	Inside watershed		Outside watershed
	Number	Percent	Number
Pre-existing NMPs not updated	25	42.4	---
Pre-existing NMPs updated	12	20.4	14
New NMPs	22	37.3	25
Expedited NMPs	---	---	6
Total NMPs	59	100.0	---

- NMPs outside the watershed are producers near the watershed who were interested in the project.
- Total pasture area with NMPs as of Fall 2008
 Inside watershed: 1,182.5 ha
 Outside watershed: 3,967.9 ha



Stewardship Recognition Program

- A recognition program was developed for producers who wanted to show that they practiced environmental stewardship and wanted to encourage others to do likewise.
- Producers were required to meet certain criteria before a stewardship sign was placed along the roadside at their farm.
- To date, 54 signs have been placed. In addition, there have been inquiries about the program from producers outside the watershed.





PURDUE UNIVERSITY
AGRICULTURAL AND BIOLOGICAL ENGINEERING

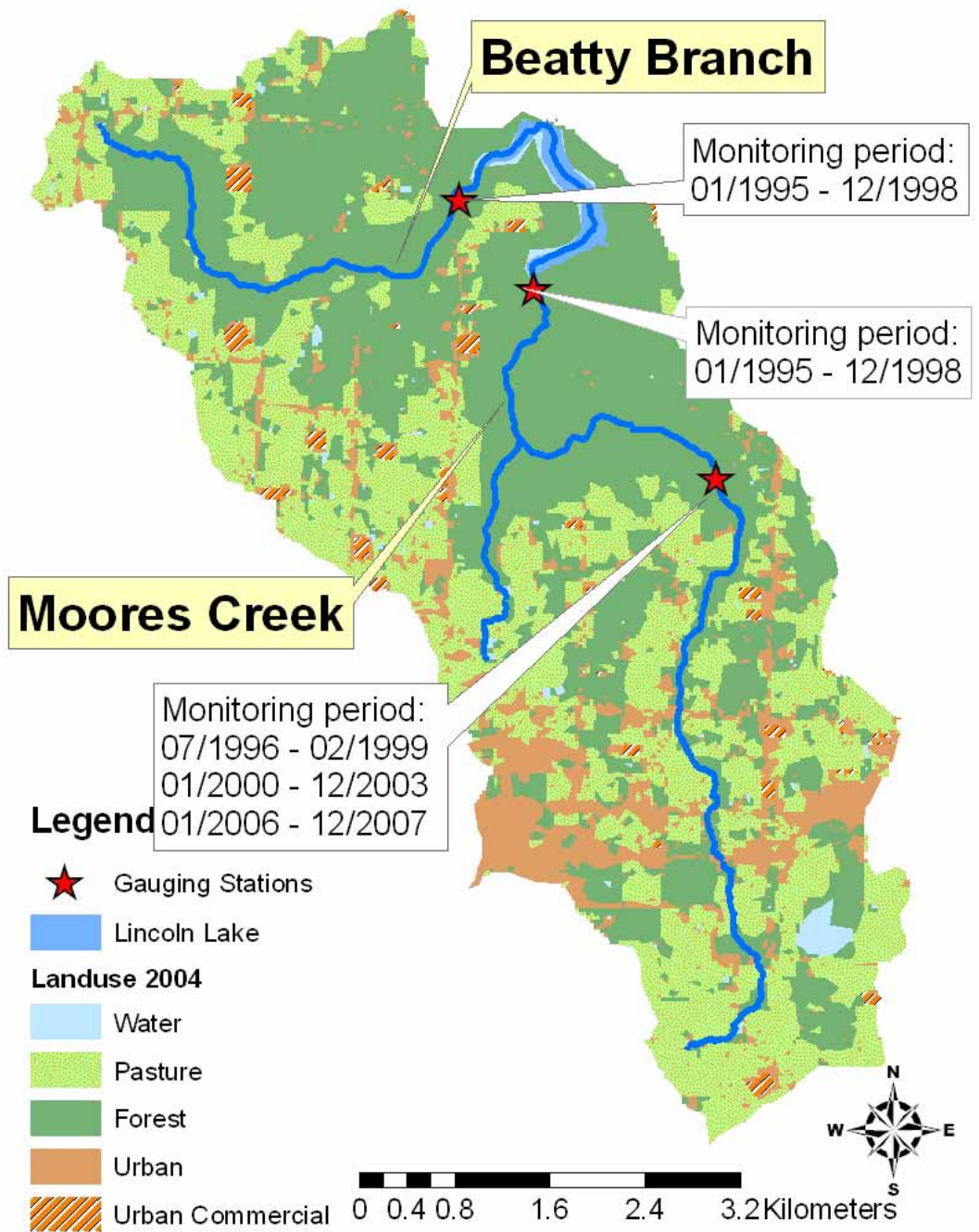
U of A
UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE



Conclusions

- Prior to 2001 NMP and BMP usage was uncommon but slowly growing over time.
- Since the inception of the current project, evidence of interest in BMP usage and actual usage has dramatically increased. This can be attributed to the educational efforts and support for producers as part of the outreach portion of this project.

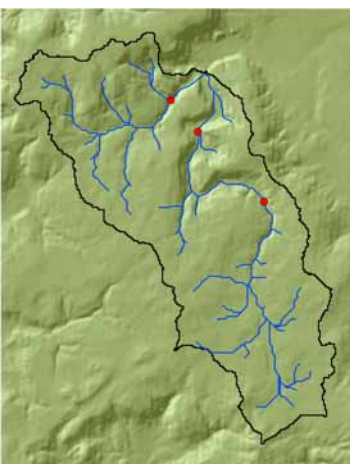




Statistical Analysis

- Raw data were used to calculate monthly flow weighted means, which in turn were used to calculate yearly flow weighted means.
- Variables included in our analysis were:
 - flow volume (L)
 - nitrate nitrogen concentration (mg/L)
 - total phosphorus concentration (mg/L)
 - total suspended solids concentration (mg/L)
- A straight line regression model was fit to each of the four variables as a function of time (year – 1990).
- Yearly means based on four months or less (e.g., Oct. – Dec. 1991) were removed from the analysis if they were outliers in the regression modeling.
- A significance level of 0.10 was used.



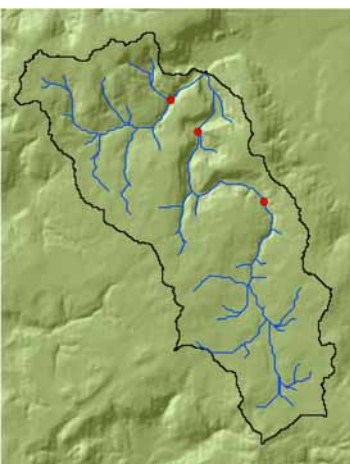


Results of Regression Modeling

Beatty Branch (1991 – 1998)

Variable	Intercept	Standard error	Slope	Standard error	p-value for $H_0: \text{slope} = 0$
Base flow conditions					
Flow ($L \times 10^8$)	11.272	5.742	0.191	1.137	0.8719
NO ₃ – N (mg/L)	0.507	0.128	0.038	0.024	0.1732
Total P (mg/L)	0.138	0.031	-0.001	0.006	0.9053
Total suspended solids (mg/L)	18.276	5.084	-0.691	1.006	0.5180
Storm flow conditions					
Flow ($L \times 10^8$)	17.722	9.336	-0.562	1.849	0.7713
NO ₃ – N (mg/L)	0.354	0.264	0.072	0.049	0.2047
Total P (mg/L)	0.284	0.200	0.019	0.045	0.6897
Total suspended solids (mg/L)	48.867	11.432	-2.201	2.611	0.4467

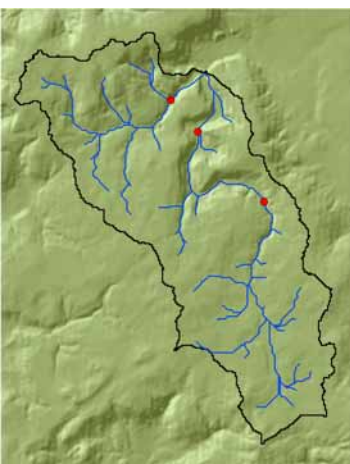




Lower Moores Creek (1991 – 1998)

	Intercept	Standard error	Slope	Standard error	p-value for $H_0: \text{slope} = 0$
Base flow conditions					
Flow ($L \times 10^8$)	6.088	6.236	3.089	1.235	0.0465
NO ₃ – N (mg/L)	0.591	0.209	0.081	0.388	0.0927
Total P (mg/L)	0.172	0.033	-0.004	0.006	0.5272
Total suspended solids (mg/L)	8.175	4.040	0.880	0.825	0.3348
Storm flow conditions					
Flow ($L \times 10^8$)	45.549	15.866	-2.735	3.142	0.4174
NO ₃ – N (mg/L)	0.446	0.073	0.076	0.014	0.0026
Total P (mg/L)	0.277	0.050	0.042	0.011	0.0133
Total suspended solids (mg/L)	44.640	40.075	12.398	8.961	0.2251





Upper Moores Creek (1996 – 2007)

	Intercept	Standard error	Slope	Standard error	p-value for $H_0: \text{slope} = 0$
Base flow conditions					
Flow ($L \times 10^8$)	11.136	9.387	0.621	0.820	0.4709
$NO_3 - N$ (mg/L)	2.027	0.973	-0.024	0.085	0.7865
Total P (mg/L)	0.351	0.059	-0.0160	0.005	0.0153
Total suspended solids (mg/L)	84.698	19.243	-5.307	1.1682	0.0135
Storm flow conditions					
Flow ($L \times 10^8$)	13.003	7.141	0.078	0.624	0.9038
$NO_3 - N$ (mg/L)	0.789	0.264	0.035	0.023	0.1642
Total P (mg/L)	1.141	0.342	-0.022	0.030	0.4660
Total suspended solids (mg/L)	677.077	246.368	-31.611	21.533	0.1803



Conclusions

- **Beatty Branch** – Lack of significant trends is not surprising since over the period from 1991 to 1998, for all practical purposes, there were no **BMPs** within this sub-watershed and minimal change in land use.
- **Lower Moores Creek** – Trends under base flow conditions for flow and total suspended solids (even though the latter is not significant) may be explained at least partially by the effect of the logging which took place in the Fall of 1995. This did not appear to be the case under storm flow conditions, except perhaps for total suspended solids.
- **Upper Moores Creek** – Downward trends under both base and storm flow conditions may be related to the impact of the large number of new **BMPs** implemented between 2005 and 2007.



Thank you.



PURDUE UNIVERSITY
AGRICULTURAL AND BIOLOGICAL ENGINEERING

UofA
UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE

