



What Factors Influence Water Quality in Lincoln Lake Watershed? Perceptions of Important Stakeholders

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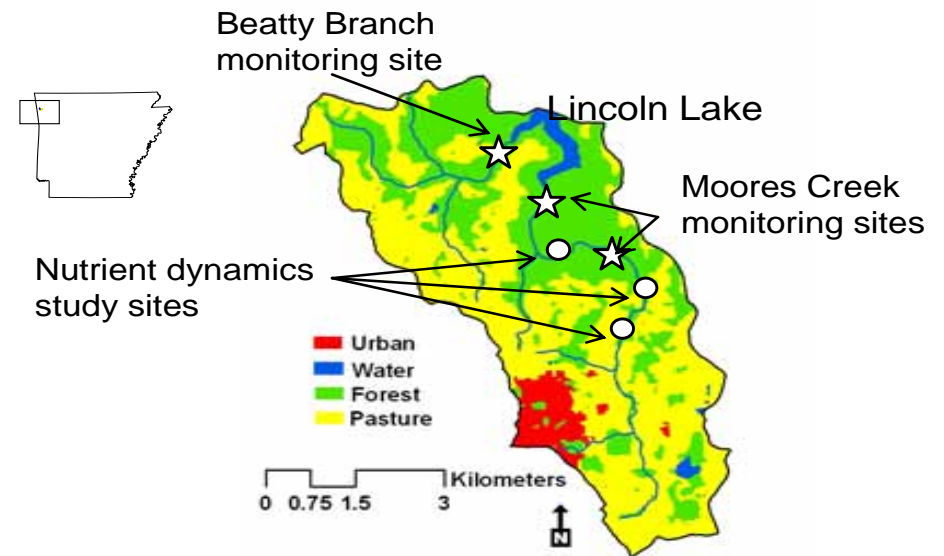
CEAP Project 2005-48619-03334

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Lincoln Lake Watershed

- Rapidly growing urban but still home to farms and industry
- Subject to debate due to nutrient enrichment
- Lawsuits exist
- Resolution depends upon understanding of:
 - Cause and nature of water quality problems
 - Management plan by stakeholders

Location and land use of Lincoln Lake Watershed in Arkansas



2005 CEAP Project

Purpose:

to integrate research, extension and education activities through a **stakeholder guided process** to measure, model and predict water quality in the Lincoln Lake Watershed



Purpose of Presentation

Address the stakeholder-guided process to understand water quality related perceptions across three stakeholder groups:

- Agricultural (Ag)
- Non-Agricultural (Non-Ag)
- Specialists



Stakeholders

Agricultural (Ag)

Individuals that own or operate agricultural operations within the watershed



Stakeholders

Non-Agricultural (Non-Ag)

Households, business owners and other landowners within the watershed



Stakeholders

County/State/Federal (Specialists)

Natural resource specialists and water regulators from several local, state and federal institutions within the state





Methods

**Development of three stakeholders surveys
(Ag, Non-Ag, Specialist) regarding perceptions of:**

- Watershed water quality (WQ)
- Potential sources of WQ degradation
- Parties responsible for cleanup
 - Non-Ag only: willingness to pay for improved water quality
- Effectiveness of 15 locally relevant agricultural BMPs to reduce nutrient/sediment runoff
- Interactions with policy leaders on WQ issues



Results

Selected characteristics of survey respondents by agricultural activity

Activity	Percent of respond in activity	Number (houses, head or acres)
Broiler production	19.7	48 ^a
Other poultry	14.8	31 ^a
Beef cattle	60.7	2,294 ^b
Other livestock	16.4	168 ^b
Hay production	59.0	1,048 ^c
Pasture production	42.6	1,033 ^c
Other activities	18.0	216 ^c

a = houses, b = head, c = acres

Ag stakeholders:

- 63 out of 75
84% response rate
- All farmers that were contacted reached agreed to do survey



Results

Land use of non-agriculture survey respondents

Land Use	%
Primary Residence	81.4
Business Operations	22.0
Rental Property	13.6
Land Preservation	10.2

Location of home, business or land in Lincoln Lake Watershed

Tributary	%
Beatty Branch	18.3
Moores Creek	81.7

Non-Ag stakeholders:

- 68 out of 243
28% response rate
- Four individuals mailed back surveys blank



Results

Specialist responses by employer groups

Employed by	% of Total Respondents
UA Experiment Station	10.7
UA Cooperative Extension Service	29.3
Conservation District	8.0
Natural Resources Conservation Service	25.3
Arkansas Department of Environmental Quality	8.0
Arkansas Natural Resources Commission	18.7

Specialist stakeholders:

– 78 out of 160

49% response rate

– Six institutions were represented

Results

General perceptions that water is good for drinking (if treated) in the Lincoln Lake Watershed lakes and streams (% respondents)

Level	Lincoln Lake (p = 0.2393)*			Moores Creek (p = 0.0240)*			Beatty Branch (p=0.0067)*		
	Ag	Non-Ag	Specialist	Ag	Non-Ag	Specialist	Ag	Non-Ag	Specialist
Agree	79.4	60.9	72.2	79.0	55.0	61.1	78.7	47.2	55.6
Neutral	14.3	25.0	16.7	14.5	33.3	16.7	16.4	39.6	27.8
Disagree	6.4	14.1	11.1	6.5	11.7	22.2	4.9	13.2	16.7

* Indicates Fisher Exact test used, otherwise test for equality of distribution of the three groups was conducted with a chi-square. Table entry as a percentage of respondents in that group selecting that response

Results

General perceptions that water is good for fishing in the Lincoln Lake Watershed lakes and streams (% respondents)

Level	Lincoln Lake (p = 0.3078)*			Moores Creek (p = 0.4778)*			Beatty Branch (p=0.0815)*		
	Ag	Non-Ag	Specialist	Ag	Non-Ag	Specialist	Ag	Non-Ag	Specialist
Agree	77.4	73.4	57.9	60.7	44.3	50.0	58.3	34.6	44.4
Neutral	21.0	21.9	42.1	32.8	44.3	38.9	30.0	54.6	50.0
Disagree	1.6	4.7	0.0	6.6	11.5	11.1	11.7	10.9	5.6

* Indicates Fisher Exact test used, otherwise test for equality of distribution of the three groups was conducted with a chi-square. Table entry as a percentage of respondents in that group selecting that response

Results

General perceptions that water is good for swimming the Lincoln Lake Watershed lakes and streams (% respondents)

Level	Lincoln Lake ($p < 0.0001$)*			Moores Creek ($p = 0.0035$)*			Beatty Branch ($p = 0.0230$)*		
	Ag	Non-Ag	Specialist	Ag	Non-Ag	Specialist	Ag	Non-Ag	Specialist
Agree	58.1	20.3	22.2	45.9	18.3	22.2	43.3	16.4	22.2
Neutral	32.3	40.6	55.6	41.0	43.3	50.0	38.3	50.9	55.6
Disagree	9.7	39.1	22.2	13.1	38.3	27.8	18.3	32.7	22.2

* Indicates Fisher Exact test used, otherwise test for equality of distribution of the three groups was conducted with a chi-square. Table entry as a percentage of respondents in that group selecting that response



Results

Perceptions as to who contributes to any existing water quality problems
(% respondents)

Group	Agricultural			Non-Agricultural			Specialist		
	None	Small	Large	None	Small	Large	None	Small	Large
New construction (p=0.0003)	9.7	38.7	51.6	20.3	40.7	39.0	1.3	27.6	71.1
Industry (p=0.0019)	21.0	50.0	29.0	23.3	46.7	30.0	1.4	55.4	43.2
City sewer system (p=0.0014)	19.7	54.1	26.2	12.5	57.1	30.4	1.3	49.4	49.3
Households (p=0.0033)	19.4	56.5	24.2	18.6	57.6	23.7	1.3	59.7	39.0
Outdoor recreation (p=0.0094)	54.1	41.0	4.9	50.9	40.4	8.7	25.0	73.7	1.3
Agriculture (p<0.0001)	19.4	75.8	4.8	6.6	52.5	41.0	1.3	53.3	45.4

* Indicates Fisher Exact test used, otherwise test for equality of distribution of the three groups was conducted with a chi-square. Table entry as a percentage of respondents in that group selecting that response



Results

Perceptions as to who contributes to any existing water quality problems
(% respondents)

Group contributor of pollution (%)				P-value
	Agricultural		Non-Agricultural		
	Small	Large	Small	Large	
New construction	38.7	51.6	40.7	39.0	0.1616
Industry	50.0	29.0	46.7	30.0	0.8206
City sewer system	54.1	26.2	57.1	30.4	0.6527
Households	56.5	24.2	57.6	23.7	0.9800
Outdoor recreation	41.0	4.9	40.4	8.7	0.6182
Agriculture	75.8	4.8	52.5	41.0	<0.0001

* Indicates Fisher Exact test used, otherwise test for equality of distribution of the three groups was conducted with a chi-square. Table entry as a percentage of respondents in that group selecting that response



Results

Perceptions as to who should be responsible to clean up (% respondents)

Group	Agricultural			Non-Agricultural			Specialist		
	None	Small	Large	None	Small	Large	None	Small	Large
New construction (p=0.0007)	9.8	36.1	54.1	14.0	42.1	43.9	1.3	29.3	69.4
Industry (p=0.0001)	12.9	50.0	37.1	13.2	45.3	41.5	0.0	43.2	56.8
City sewer system (p<0.0001)	21.0	53.2	25.8	14.8	44.4	40.7	0.0	37.3	62.7
Households (p=0.1376)	19.7	55.7	24.6	20.0	54.6	25.5	5.6	59.7	34.7
Outdoor recreation (p<0.0001)	47.5	47.5	5.0	47.2	35.9	17.0	22.2	68.1	9.7
Agriculture (p<0.0007)	25.0	66.7	8.3	16.7	43.3	40.0	2.7	50.0	47.3

* Indicates Fisher Exact test used, otherwise test for equality of distribution of the three groups was conducted with a chi-square. Table entry as a percentage of respondents in that group selecting that response

Results

Logit model to estimate Non-Agricultural's willingness to pay for water quality

Parameter	Estimated Logit Coefficients	Standard Error	ChiSq Probability	Odd Ratios
Agrees that water quality problems exist in the watershed	1.5660	0.8031	0.0429	4.79

- Not significant in model
 - Amount asked to pay
 - Perception of who was responsible for any existing water quality problems



Are these BMPs Effective?

- Controlled Grazing
- Vegetative Filter Strips
- Riparian Buffers
- Utilization of Warm and Cool Season Forages
- Stream Bank Stabilization
- Stream Fencing
- Litter Storage Shed
- Soil Testing
- Manure Composting
- Use of Legumes
- Use of NMP
- Manure Fertilization
- Basing Fertilization on Soil Test Results
- Prescribed Grazing
- Cattle Track Stabilization and Improvement

Results

Best management practices believed to be effective in reducing sediment and/or nutrient loss from agricultural lands (% respondents)

BMP	Agricultural			Specialist		
	Agree	Disagree	Not Sure	Agree	Disagree	Not Sure
Soil test (p=0.1266)*	86.4	1.7	11.9	87.0	7.8	5.2
Use of manure instead of commercial fertilizer (p=0.0001)	82.1	3.6	14.3	52.0	32.5	15.6
Basing fertilizer application on soil test results (p=0.0031)	80.0	5.0	15.0	97.3	0.0	2.7
Pasture grass management (p=0.2997)*	82.5	7.0	10.5	90.8	5.3	4.0
CNMP (p< .0001)*	51.8	8.9	39.3	92.1	6.6	1.3

* Indicates Fisher Exact test was used, otherwise test was conducted with a Chi-square

Results



Beliefs that a specific level of government represents their water needs and concerns best (% respondents)

Government Level	Agricultural	Non-Agricultural	Specialist
County	83.1	68.1	36.2
State	13.6	23.4	37.7
Federal	3.4	8.51	26.1

$p = 0.0604$

Government Level	Agricultural	Specialist
County	83.1	36.2
State	13.6	37.7
Federal	3.4	26.1

$p < 0.0001$



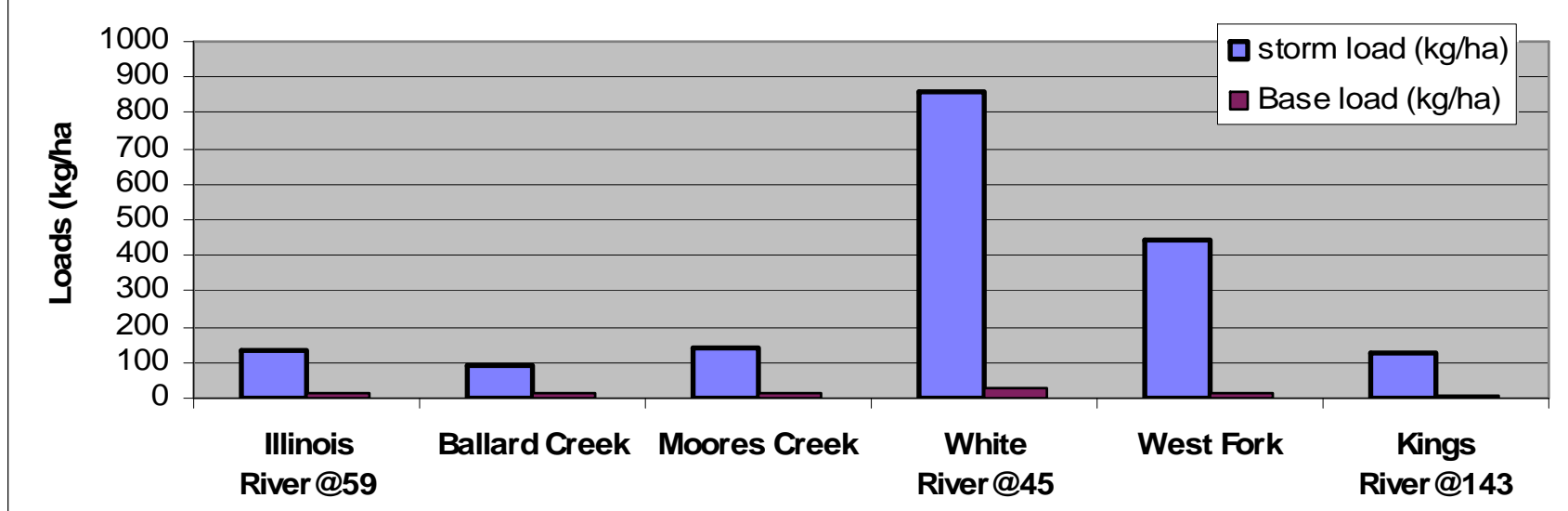
Results

Percentage of respondents that believe government officials invite to participate and listen to their opinions regarding water quality

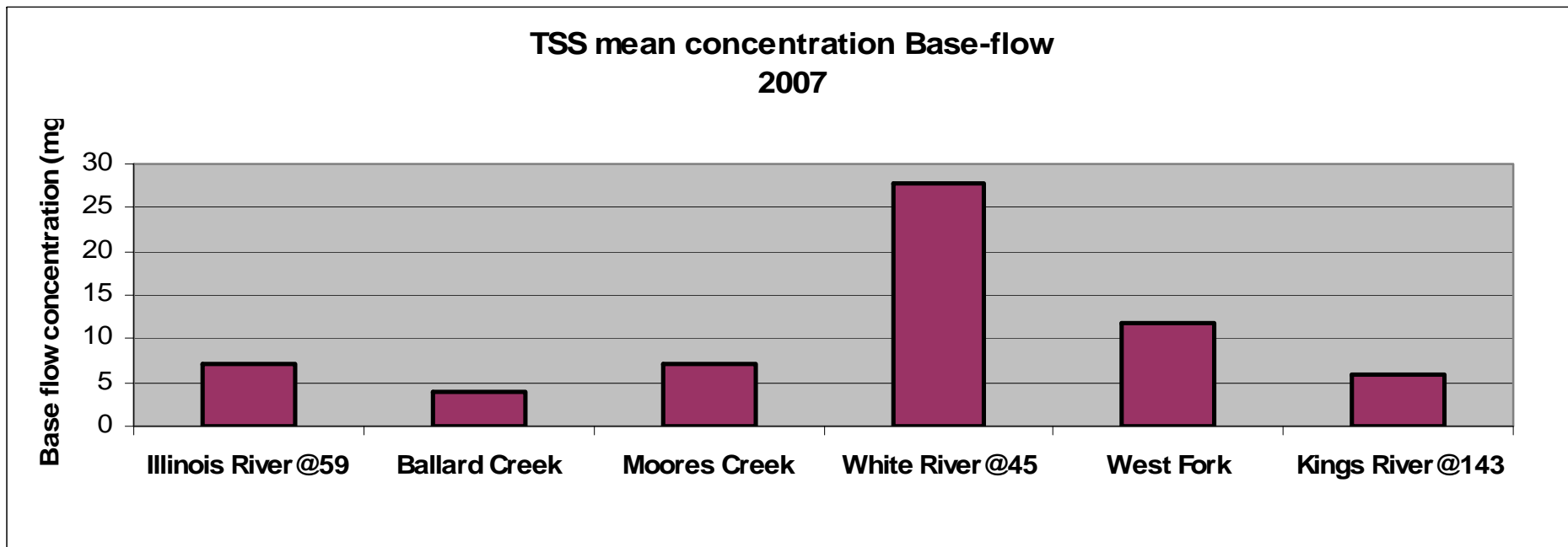
Government	Agricultural	Non-Agricultural
Invite	46.55	43.64
Listen	19.35	28.30

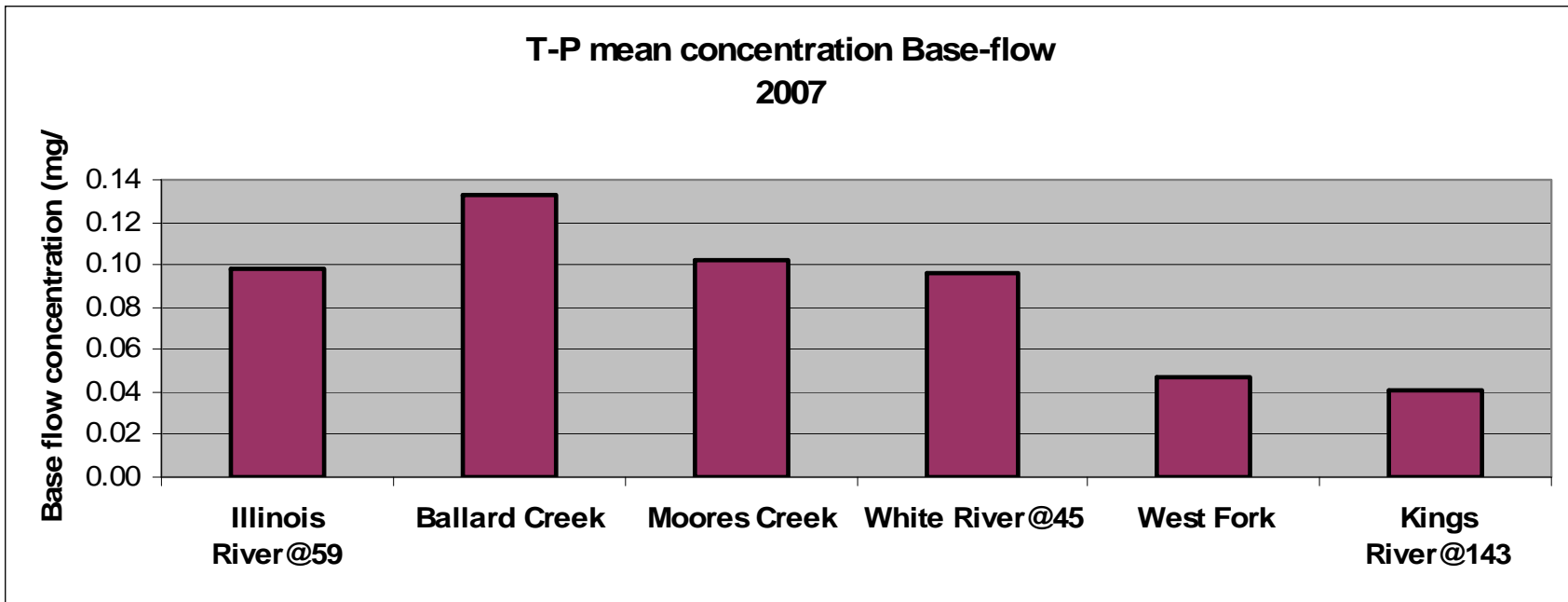
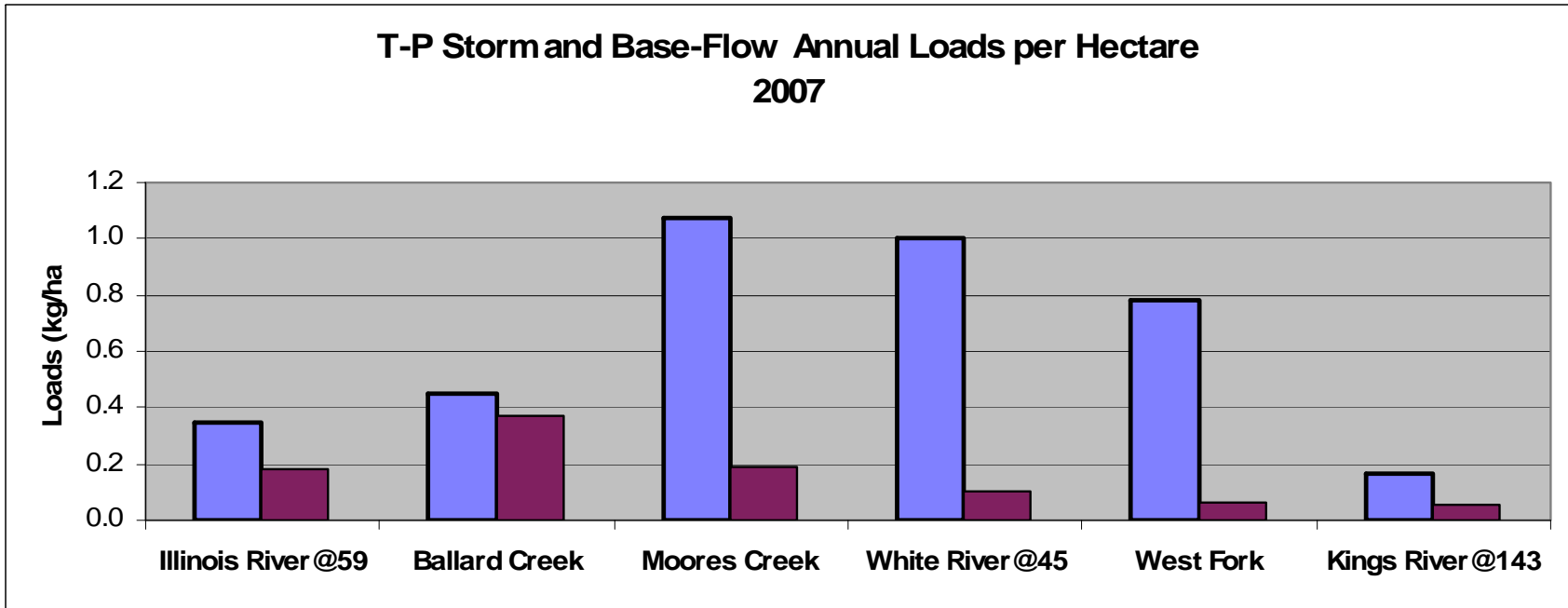
$p < 0.1833$

**TSS Storm and Base-Flow Annual Loads per Hectare
2007**

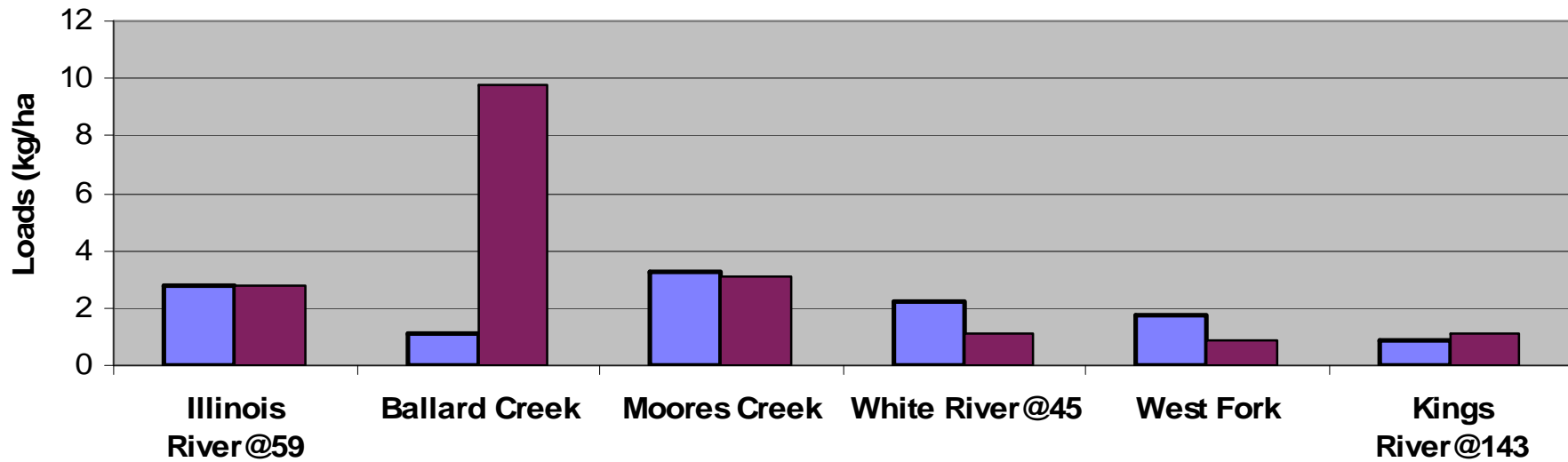


**TSS mean concentration Base-flow
2007**

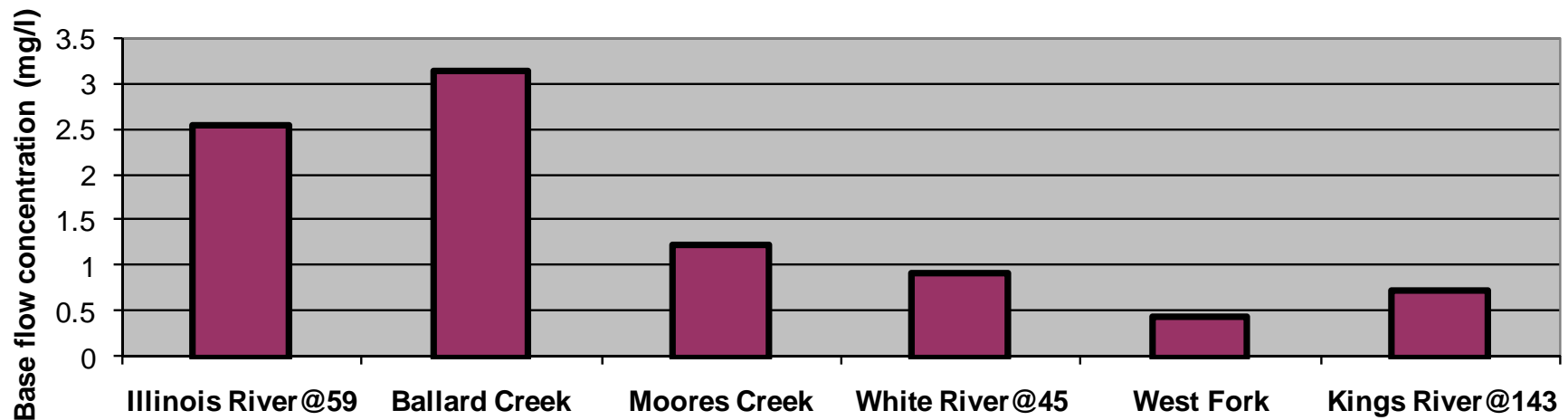




Total Nitrogen Storm and Base-Flow Annual Loads per Hectare 2007



Nitrate Nitrogen mean concentration Base-flow 2007





Take Home Messages

1. Opinions across stakeholder groups are not always at odds regarding water quality (drinking/fishing)
2. All stakeholder groups believe wq problems are generated from multiple sources
 - Agricultural and non-agricultural residents/landowners only disagree about extent of agriculture's contributions
3. Most non-agricultural respondents were willing to pay to improve water quality
 - perceived source of pollution didn't matter



Take Home Messages

4. Specialists and agricultural producers don't always agree on effectiveness of BMPs
 - Non-ag groups don't generally understand ag BMPs

5. Agricultural and non-agricultural groups don't feel engaged in the policy process

Ongoing Work

Purdue University

- Water quality modeling in SWAT

Division of Agriculture

- Risks and returns associated with various BMPs
- BMP optimization (genetic algorithm)
- Sign Program





For More Information

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Comparison of Standards

- Drinking Water Standard
 - P – none
 - Total N – 10 mg/l of water
 - TSS – 500 mg/l of water
 - Water going into treatment plant