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ILLINOIS RIVER VOLUNTEER MONITORING

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EXECUTIVE SUMMARY

Understanding how water quality conditions change along a land use gradient and over time is important for sustainable watershed management. Therefore, a volunteer monitoring program was created to measure water chemistry at 37 established sites within the Upper Illinois River Watershed and to evaluate changes in water chemistry over the past 15 years. The Illinois River Watershed Partnership (IRWP), a non-profit organization subcontracted with the Arkansas Water Resources Center at the University of Arkansas, to manage the volunteer monitoring project, train volunteers to collect samples following EPA approved methods, and to analyze the collected samples. The AWRC trained 27 volunteers to collect water samples at 37 sites that were previously sampled in 1993 and 1994. Samples were collected during baseflow conditions during September and December 2008 and February and May 2009 and analyzed for soluble reactive phosphorus, nitrate-nitrogen, sulfate, chloride, fluoride, total phosphorus, total nitrogen, total suspended solids, and turbidity. Geomean concentrations were calculated and compared to the concentrations observed during the 1993-1994 study. Overall, total phosphorus and soluble reactive phosphorus concentrations significantly increased at 14% and 11% of the sampled sites, respectively, between the previous and current studies, while respective concentrations significantly decreased at 8% and 16% of sampled sites. The greatest reductions in phosphorus concentrations occurred at sites downstream of effluent discharges, and both total phosphorus and soluble reactive phoshporus concentrations were positevely correlated to pasture and urban land use within the catchment (R^2= 0.11, P=0.045; R^2= 0.16, P=0.015, respectively). Similarly, both total nitrogen and nitrate-nitrogen concentrations were positvely correlated to urban and pasture land use (R^2= 0.38, P <0.0001; R^2=0.29, P=0.0006, respectively), and 5% and 14% of the sampled sites significantly increased in total nitrogen and nitrate nitrogen concentrations, respectively, between the two study periods. Overall, very few significant changes in water quality (i.e., water chemistry) were observed over the last 15 years; those changes that were most noticeable resulted from either improvements in the phosphorus mangement of waterwater treatment facilities or the introdiction of effluent discharge into a new receiving stream. Volunteer monitoring programs are an excellent way to promote environmental education and stewardship, and these programs can be useful in documenting changes in watershed conditions over time.

INTRODUCTION

Excessive loading of nitrogen, phosphorus, and sediment throughout a watershed can impact water quality and prevent streams from supporting designated uses (e.g., aquatic life, recreational contact etc.). Multiple factors influence water quality within a catchment including nutrient cycling and processing, surface and groundwater interaction, stream channel and riparian characteristics, as well as catchment land use. Of these, catchment land use often has a significant influence on stream nutrient concentration (Sliva and Williams, 2001), and multiple studies have shown that nutrient concentrations in streams are positively correlated to percent pasture and urban land use within its catchments, especially in the Ozark Highlands (Haggard et al., 2003, 2007). Therefore, understanding the relationship between water quality and catchment land use is important for sustainable watershed management and efforts to improve water quality conditions.

The presence or absence of riparian buffers also plays an important role in the water quality conditions of streams, and whether or not streams are maintaining healthy aquatic communities. Riparian forest buffers filter nutrients and sediment from runoff and are well established best management practices that improve many facets of stream water quality. Anthropogenic changes to land use (i.e., conversion to pasture and urban areas) and removal of riparian forest buffers can alter the benefits and thus contribute to degraded water quality conditions. However, land use is not the only environmental stressor and contributor to elevated nutrient concentrations in streams.

Effluent discharge from wastewater treatment plants (WWTP) has a substantial effect on base flow and nutrient concentrations in streams, especially in relatively small Ozark streams (e.g., see Ekka et al., 2006). Often, streams that receive effluent discharge do not fit the statistical relation between stream nutrient concentrations and catchment land use; the sites downstream from effluent discharges often have significantly greater phosphorus concentrations compared to upstream and other streams with similar land use distributions. Effluent discharges reduce a stream’s ability to retain nutrients efficiently (Haggard et al., 2005), limiting a stream’s ability to delay the transport of nutrients from other sources.

It is important to understand how water quality conditions change along a land use gradient and over time, and the purpose of this study was to evaluate changes in chemical concentrations from a historical study (Parker et al., 1996) compared to that observed more recently in the Upper Illinois River Watershed (UIRW). The Illinois River Watershed Partnership (IRWP) engaged the local stakeholders within the watershed to accomplish this overall goal, where the stakeholders were utilized as trained volunteers to collect water samples at the sites selected in the historical study, such that the Arkansas Water Resources Center (AWRC) could compare water quality conditions then and now. A volunteer monitoring program provides a means to engage stakeholders in environmental education (Stokes et al., 1990), [hopefully] promoting a sense of responsibility for stakeholders to protect and improve water quality. The use of volunteers provides a means to get the community involved, and it is also economical; however, some studies have shown that volunteer data can be spatially and temporally variable compared to professionally collected data (Savan et al., 2003). So, a balance must exist between the collection of water-quality data using volunteers and professionals where stakeholder education is advanced without a loss in the quality of data as perceived by regulatory authorities and others.

METHODS

Study Site Description

The Upper Illinois River Watershed lies in the Ozark Plateau of northwest Arkansas; the headwaters of the Illinois River originate near Hogeye in northwest Arkansas, and the river flows northwesterly through the Ozarks, into Oklahoma and eventually into Lake Tenkiller Ferry. The main tributaries to the Illinois River in northwest Arkansas include Osage Creek, Clear Creek, and Muddy Fork. These tributaries, as well as the Illinois River itself, drain 757 mi^2 that are primarily forest (41%) and agricultural lands (i.e., pasture and forages; 46%). However, over the past decade increases in residential, commercial and industrial development have been observed (i.e., urban land use has increased to 13%). The Upper Illinois River has several designated uses including recreation, aquatic life and refuge, and agricultural, industrial and residential water supply by some communities in northwest Arkansas and northeast Oklahoma. In addition, the Upper Illinois River and its tributaries provide the ecological service of wastewater treatment as several tributaries receive treated effluent from wastewater treatment plants including Goose Creek, Osage Creek, Sager Creek, and Spring Creek.

The Illinois River is center to many political, scientific and legal debates because it has been designated as a Scenic River in Oklahoma with a numeric water quality standard for total phosphorus concentrations (i.e., 0.037 mg L^{-1}). While this numeric standard is not a regulatory water quality standard in the Arkansas portion of the Illinois River, the State of Arkansas has agreed to reduce phosphorus loading to Oklahoma, and the Arkansas Natural Resources Commission (ANRC) has also listed the Illinois River drainage area as a priority 319 watershed. In addition, reaches including Muddy Fork, Clear Creek, Osage Creek, Spring Creek and Little Osage Creek were listed on Arkansas Department of Environmental Quality's (ADEQ) 303d list or added to the list by the U.S. Environmental Protection Agency (USEPA) for impairment by nutrients, sediment and or bacteria.

Sample Collection

Volunteer monitors (i.e., IRWP Stream Team Volunteers; Appendix 1) collected water samples during base flow conditions at 37 sites (See Appendix 2) spanning the UIRW; these were the same sites that were sampled during a comprehensive watershed study in 1993 and 1994 by Parker et al. (1996). Base flow conditions were defined for this study to be all stream conditions a minimum of three days following a rain event when stream water was not visibly turbid (i.e., muddy). Volunteers were trained at the respective sampling site(s) by AWRC (Fayetteville, Arkansas) personnel to collect and handle water samples following a USEPA approved quality assurance project plan (QAPP). Trained volunteers collected water samples during the months of September and December 2008 and March and May 2009; grab samples were collected in-stream from the vertical centroid of flow just below the surface of the water (i.e., where the stream is well-mixed). The water samples were delivered immediately or refrigerated and delivered within one business day to the AWRC Water Quality Laboratory where the samples were analyzed for nitrate-nitrogen (NO_3-N), soluble reactive phosphorus (SRP), total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), chloride (Cl^-), fluoride (F), sulfate (SO_4), turbidity and conductivity. A duplicate sample was collected by an AWRC field services technician at 25% of the sites each quarter and analyzed for the same constituents as a check against the volunteer data. All water samples were analyzed following standard analytical procedures as outlined within the QAPP of the water quality lab.

Statistical Analysis and Prioritization

Average constituent concentrations during base flow conditions were determined by calculating the geomean of the four samples collected by the volunteer monitors and the sample collected by the AWRC field services technician (n=5). Individual constituent concentrations were natural log (ln) transformed and used in students t-test (JMP 8; 2008, SAS Institute Inc.) to determine differences in mean constituent concentrations between the current volunteer monitoring program and the data collected by Parker et al. (1996). All comparisons were conducted between data collected during base flow conditions, and a significance level of 0.05 was used for all statistical comparisons.

The sub-watersheds were prioritized following the method of Parker et al. (1996) where the rankings were divided into roughly thirds to represent the priority rankings (i.e., high, medium and low). The sampled sites were prioritized based on the geomean constituent concentration during base flow at each site, and the sampled sites were prioritized based on four different constituents (i.e., TP, SRP, TN and NO_3-N). For comparison purposes, historical data collected by Parker et al., 1996 was prioritized in the same way using baseflow constituent concentrations. However, we also present the priority rankings based on unit loads as reported by Parker et al. (1996).

RESULTS AND DISCUSSION

Concentrations and Land use

Conductivity and Chloride. Conductivity was within expected ranges across the streams draining the different land use distributions; conductivity ranged from 112 to 172 $\mu S\ cm^{-1}$ at primarily forested sites and was much greater at sites downstream from WWTP effluent discharge points (i.e., from 360 to 470 $\mu S\ cm^{-1}$). The highest conductivity (470 $\mu S\ cm^{-1}$) was measured at Spring Creek which receives the treated effluent from the City of Springdale's WWTP. Conductivity typically decreases with increasing distance from an effluent discharge point (e.g., see Ekka et al., 2006), and conductivity measurements were substantially less in the main stem of the Illinois River downstream from these tributary inflows, likely due to dilution from other tributaries and ground water inflows.

Chloride, a conservative ion tracer, was positively correlated to conductivity at the sampled sites (R^2= 0.59, $P<0.0001$). Chloride concentrations downstream of WWTPs were generally more than five times greater than concentrations observed at predominantly forested sites. Measured chloride concentrations were similar to historic concentrations (see Parker et al., 1996) at most sites; significant increases were observed at two sites where urban land use more than doubled over the last 15 years (e.g., Sites 21 and 30), and at Site 3 (Goose Creek) which began receiving treated effluent from one of the City of Fayetteville's WWTP in 2008. Across the watershed, the geomean of chloride concentrations during base flow conditions ranged from 2.7 to 38.5 mg L^{-1}, and concentrations were positively correlated to pasture and urban land use (R^2= 0.23, P=0.003, figure 1). However, the relationship between land use and geomean nutrient concentrations explains less than half the variability in the data reflecting the complexity of how catchment attributes influence stream water chemistry.

Nitrogen. Several studies have shown that nitrogen concentrations in streams are strongly related to human activates and catchment land use (e.g., see Haggard et al., 2003, 2007). During this study, the geomean of TN concentrations during base flow ranged from 0.39 mg L^{-1} to 4.49 mg L^{-1} across the UIRW. Nitrogen in these streams is typically present in the form of NO_3; NO_3-N concentrations ranged from 0.31 mg L^{-1} to 4.47 mg L^{-1}, representing approximately 80% of the in-stream total nitrogen concentrations. The highest TN and nitrate concentrations were observed at sites that are influenced by nonpoint sources, not effluent discharges, and both TN and nitrate were positively correlated with urban and pasture land use (R^2= 0.38, P <0.0001; R^2=0.29, P=0.0006, respectively).

Between the current study and the previous study conducted by Parker et al. (1996), 14% of the sampled sites (i.e., Sites 1, 5, 14, 17, and 22) exhibited a significant increase in NO_3-N concentration, while only one site (Site 5) exhibited a significant increase in TN concentration. These changes occurred even though urban land use increased by less than 5% and pasture land use decreased by up to 25% at these sites. Nitrate primarily moves through groundwater and lateral flows, which might suggest that these increases reflect the legacy of historic land use and management. Other sites showed that stream nitrogen concentrations significantly decreased, likely resulting from changes in land use as well as the potential implementation of best management practices (BMPs).

Phosphorus. In the UIRW, phosphorus has typically been the predominant constituent of concern as phosphorus tends to be the limiting nutrient in Ozark streams (e.g., see Matlock et al., 1998; Popova et al., 2006; Ludwig, 2007). During this study (September 2008 through May 2009), TP concentrations varied spatially ranging from 0.02 mg L^{-1} to 0.14 mg L^{-1} during base flow conditions. The low was at Site 36 (Upper Evansville Creek), a predominantly forested catchment, and the high was at Site 16 (Spring Creek), downstream from the City of Springdale's WWTP effluent discharge point. In fact, 80% of the sites with a TP concentration greater than 0.1 mg L^{-1} were downstream of WWTP effluent discharges. But, TP concentrations decreased with increasing distance from the effluent discharge point due to dilution and or in-stream processes (Ekka et al., 2006), and the TP concentration in the Illinois River downstream of the tributary inflows (Site 8) was approximately 0.07 mg L^{-1}. The same spatial pattern was observed in SRP concentrations which makes up the majority of the TP in these streams (i.e., SRP >50% of TP concentration); SRP concentrations ranged from 0.01 mg L^{-1} to 0.14 mg L^{-1}. Elevated P concentrations during base flow conditions were also observed at sites that drain predominantly pastured lands (e.g., Sites 19, 21, and 32). Both TP and SRP concentrations were positively correlated with percent pasture plus urban land use in the catchments of the sampled sites (R^2= 0.11, P=0.045; R^2= 0.16, P=0.015, respectively), although the relationships were not as strong as those observed with nitrogen and the conservative ion, chloride. It is typical that catchment land use would not explain as much of the variability in phosphorus compared to nitrogen or chloride concentration in streams (i.e., lower R^2 with phosphorus and land use correlations). Other regional studies (e.g., Haggard et al., 2003, 2007; Giovannetti, 2007) have observed this same variation, suggesting that nitrogen (particularly NO_3)

is highly mobile whereas phosphorus (particularly phosphate) is more reactive along its flow path from the landscape through streams.

Overall, TP and SRP concentrations significantly increased at 14% and 11% of the sampled sites, respectively, between the historic (Parker et al., 1996) and current studies, while respective concentrations significantly decreased at 8% and 16% of sampled sites. The greatest reductions in P concentrations occurred at sites downstream of effluent discharges; the Cities of Rogers and Springdale, reduced effluent TP concentrations to less than 1 mg L^{-1} in 1997 and 2002, respectively. The effects of effluent P reductions were not only observed at Site 12, Osage Creek, which receives Roger's treated WWTP effluent and Site 16, Spring Creek, which receives Springdale's WWTP effluent, but these reductions were also reflected in significant reductions in P further downstream in Osage Creek and at the Illinois River (Site 25) downstream from the Osage Creek and Spring Creek inflows. The greatest increase in P concentrations occurred at Goose Creek (Site 3) which began receiving the treated effluent from the City of Fayetteville's Westside WWTP in summer 2008, and P concentrations significantly increased from 0.04 to 0.21 mg L^{-1} at this site.

Sediments and Turbidity. During this study, turbidity was generally low but variable throughout the UIRW; turbidity was not correlated to catchment land use across these selected sites. Arkansas DEQ Regulation 2 (ADEQ, 2007) provides numerical standards of 10 NTU during base flow conditions or 17 NTU during all flow conditions in the Ozark Highlands. Geomean values of turbidity during base flow conditions ranged from <1 to 11 NTU, and measured NTUs were less than the defined water quality standards for Ozark streams. Site 21, Lower Moores Creek, was the only site that had turbidity values exceeding the numeric criterion applicable during base flow conditions across these sampling sites.

Turbidity was positively correlated to TSS at the sampled sites in the UIRW (R^2= 0.67; P<0.0001), which would be expected since TSS represents material suspended within the water column. Throughout the UIRW, geomean TSS concentrations ranged from 0.52 to 8.80 mg L^{-1}, and measured concentrations during base flow conditions were not correlated to pasture and urban land use. However, both sites (i.e., Sites 15 and 21) with geomean TSS concentrations greater than 5 mg L^{-1} during base flow conditions drained catchments where the predominant land use was pasture. Total suspended solids concentrations did not significantly increase at any of the sampled sites in the UIRW between the two study periods, but TSS concentrations were significantly less at 8% of the sampled sites (e.g., Sites 4, 7, and 20). The greatest percentage of land use at these sites during the previous study (Parker et al., 1996) was pasture, but since then, pasture has been converted to forested and urban areas; forest is now the greatest land use at each of these sites. Despite overall low TSS concentrations (and turbidity) across the UIRW, there are two reaches on the Arkansas 303(d) list for impairment by siltation. It is important to remember that this data reflects baseflow conditions, and not storm events or the accumulation of sediments (particularly fine particles) within the fluvial channel.

Priority Rankings

Parker et al (1996) Priority Rankings. The previous study conducted by Parker et al. (1996) was a comprehensive monitoring program that sampled 37 sites in the UIRW during both base flow and during storm flow conditions, and base flow and storm flow discharge at each site was determined by a combination of measurement, modeling and estimation. From there, Parker et al. (1996) determined yearly average flow-weighted parameter concentrations and unit area loads (kg ha^{-1} $year^{-1}$), and the sub-watersheds were prioritized on the basis of the annual unit area loads. Parker et al. (1996) prioritized the sub-watersheds as a high, medium or low priority for the parameters TN, TP and TSS, and each parameter prioritization was divided into three approximately equal priority ranking groups. The prioritization rankings established by Parker et al. (1996) for TP and TN are provided in Tables 2 and 4, respectively. For TP, 16 sites were ranked low, 10 sites were ranked medium, and 11 sites were ranked high; the low, medium and high priority sub-watersheds had loads that ranged from 0.05 to 0.065 kg ha^{-1} $year^{-1}$, 0.065 to 0.95 kg ha^{-1} $year^{-1}$, and 0.95 to 1.85 kg ha^{-1} $year^{-1}$, respectively. Other studies (e.g., Beaulac and Reckhow, 1982, Young et al., 1996) reported typical unit area loads for TP of 0.3-2.8 kg ha^{-1} $year^{-1}$ for pastures and about 0.1-0.4 kg ha^{-1} $year^{-1}$ for forests. For TN, 10 sites were ranked low, 19 sites were ranked medium, and eight sites were ranked high; the low, medium and high priority sub-watersheds had loads that ranged from 0 to 5 kg ha^{-1} $year^{-1}$, 5 to 15 kg ha^{-1} $year^{-1}$, and 15 to 50 kg ha^{-1} $year^{-1}$, respectively. The typical export for TN has been reported to be within 2-11 kg ha^{-1} $year^{-1}$ from pastures and 2-3.5 kg ha^{-1} $year^{-1}$ from forests (see Beaulac and Reckhow, 1982, Young et al., 1996).

Historical Base Flow Priority Rankings. The purpose of the current project, as established in the work plan submitted to ANRC and funded as ANRC Project 08-400, was to collect quarterly grab samples during base flow at the established 37 sites using trained volunteers, to prioritize the sub-watersheds based on the collected data, and to compare the current data to past results (i.e., Parker et al., 1996). Since samples were only collected during base flow conditions during the current study, only the base flow data from the previous study could be considered to effectively compare water quality then (i.e., 1993-1994) and now (i.e., 2008-2009). Therefore, geomean base flow constituent concentrations of the measured data collected by Parker et al. (1996) were calculated and used to rank the sites as high, medium or low priority where the prioritization was divided into three approximately equal priority rankings (following Parker et al, 1996). We ranked the historical base flow data as high, medium or low priorities for TP, SRP, TN, and NO_3-N, and these rankings are provided in Tables 2 through 5, respectfully. Using this prioritization method, the ranges of geomean concentrations during base flow for the low, medium and high priorities for TP were less than 0.04 mg L^{-1}, 0.04 to 0.05 mg L^{-1}, and greater than 0.05 mg L^{-1}, respectively. The ranges of geomean concentrations during base flow for the low, medium and high priorities for SRP were less than 0.02 mg L^{-1}, 0.02 to 0.04 mg L^{-1}, and greater than 0.04 mg L^{-1}, respectively. The ranges of geomean concentrations during base flow for the low, medium and high priorities for TN were less than 1.81 mg L^{-1}, 1.81 to 3.07 mg L^{-1}, and greater than 3.07 mg L^{-1}, respectively. And, the ranges of geomean concentrations during base flow for the low, medium and high priorities for NO_3-N were less than 1.45 mg L^{-1}, 1.45 to 2.60 mg L^{-1}, and greater than 2.60 mg L^{-1}, respectively.

Current Base Flow Priority Rankings. Current priority rankings were established based on current geomean constituent concentration during base flow conditions at each site. The sub-watersheds were ranked as a high, medium or low priority following the method of Parker et al. (1996), where each ranked parameter was divided into approximately equal priority groups (i.e., for TP and SRP, 16 sites were ranked low, 10 sites were ranked medium, and 11 sites were ranked high; for TN and NO_3-N, 10 sites were ranked low, 19 sites were ranked medium, and eight sites were ranked high). The concentration ranges for high, medium and low priority rankings for each constituent were similar to those of the historical base flow priority data; the current geomean concentrations during base flow conditions and respective priority rankings for TP, SRP, TN and NO_3-N are provided in Tables 2 thorough 5. The ranges of geomean concentrations during base flow for the low, medium and high priorities for TP were less than 0.04 mg L^{-1}, 0.04 to 0.07 mg L^{-1} , and greater than 0.07 mg L^{-1}, respectively. The ranges of geomean concentrations during base flow for the low, medium and high priorities for SRP were less than 0.03 mg L^{-1}, 0.03 to 0.04 mg L^{-1}, and greater than 0.04 mg L^{-1}, respectively. The ranges of geomean concentrations during base flow for the low, medium and high priorities for TN were less than 1.74 mg L^{-1}, 1.74 to 3.63 mg L^{-1}, and greater than 3.63 mg L^{-1}, respectively. And, the ranges of geomean concentrations during base flow for the low, medium and high priorities for NO_3-N were less than 1.20 mg L^{-1}, 1.20 to 3.64 mg L^{-1}, and greater than 3.64 mg L^{-1}, respectively.

Related to priority rankings, the most important changes are probably moving from low or medium to a high priority ranking, or shifting from a high priority to a lower priority ranking. With regards to TP ranking, 46% of the sampled sites changed priority rankings between the historical study (Parker et al., 1996) and the current study. Seven sites shifted from a medium priority to a high priority, while five sites shifted from a high priority to a low priority. For SRP, 41% of the sites shifted in priority rankings between the two study periods. Five sites shifted from a low or medium priority during Parker et al. (1996) study to a high priority during this study; two sites (Sites 10 and 27) moved from a high priority to a low priority. Similar to TP, 46% of the sampled sites changed priority rankings between the studies for TN. However, only two sites shifted to a high priority, and no sites shifted from a high to a low priority. For NO_3, 38% of the sites shifted in priority rankings between the two studies; four sites moved from a medium to a high priority while no sites moved from a high to a low priority.

The use of category breakpoints is arbitrary when defining priority rankings (i.e., high, medium and low) based upon approximately thirds. While the ranges that defined high, medium and low priorities were similar between the historical and current study, the sites that fell within these ranges often differed between the studies. However, the sites that exhibited significant increases or decreases in geomean concentrations did not necessarily move from one rank to another. For example, Spring Creek was ranked as a high priority during both the historical (Parker et al., 1996) and current study, but we observed a significant decrease in TP concentrations between the two study periods. Similarly, we observed a significant increase in TP concentrations at Sager Creek, yet this site ranked as a medium priority during base flow conditions for both studies (i.e., Parker et al., 1996 and the current study).

An alternative comparison would be to use the same breakpoints defined in Parker et al. (1996), and this approach would have increased the number of sites in the upper and lower categories (i.e., high and low priorities) for some constituents. It might be best to focus on the statistical comparisons of the historic data (from Parker et al., 1996) to that collected with the volunteer monitoring program, where select sites did show significant changes. The graphs of the data showing the one to one lines also provide an excellent visual tool to evaluate which direction sites moved, i.e. did concentrations during base flow conditions numerically increase or decrease between studies?. Furthermore, an alternative method of prioritization that considers existing gradients between nutrients and catchment land use may better prioritize subwatersheds within the Upper Illinois River Watershed.

Alternative Prioritization Method. As observed in this study, nutrient concentrations across Ozark streams are positively correlated to pasture and urban land use within the catchment, and simple linear regression can be used to establish "average" conditions for respective catchment land use. Thus, the sloped line from the regression analyses represents the average nutrient concentration as a function of land use. Regression analyses also provides a 95% confidence interval about this sloped line, where we would be pretty confident that the line is between the upper and lower intervals (or curves). Based on this statistical evaluation of the correlation between water quality and land use, any site that falls below the average condition at a given land use should be considered a low priority since this site would exhibit concentrations below average conditions for its catchment type. Any site that falls above the upper confidence interval (i.e., curve) could be considered a high priority as we would be 95% confident that concentrations at this site are above the average concentration along the land use gradient. Figure 3 illustrates the regression line and 95% confidence interval about the regression line for the geomean base flow data collected during this study, and it shows site numbers allowing the priority for each site to be determined following this alternative approach.

The data from the volunteer monitoring program were used to help guide the prioritization of the HUC12s contained within the larger HUC8, UIRW. Some of the sites used in the volunteer monitoring program were at location representative of the HUC 12 drainage basin, i.e., HUC 12 outlets. However, the volunteer monitoring network of sites did not represent all HUC12s capturing the hydrologic outlet. Therefore, a monitoring program would need to be designed to capture all HUC 12 outlets and it (this program) should target known effluent discharges and major tributaries with sites selected up and downstream along the Illinois River or main tributaries (e.g., Osage Creek). The VMP data would add strength to the use of this alternative watershed prioritization scheme, because these 37 sites represent the gradient of pasture plus urban land use across the UIRW. The data from this program has shown that geomean concentrations of nitrogen and phosphorus are significantly, positively correlated to catchment land use, suggesting it is feasible to prioritize the HUC 12s using this gradient.

CONCLUSIONS:

This project successfully used trained volunteers to collect water samples at 37 sites to establish current water quality conditions throughout the watershed. Some constituent concentrations from the volunteer samples were significantly different at some of the sampled sites compared to the historic data collected by Parker et al. (1996). Thus, the priority rankings of the 37 sub-watersheds were updated based on current water quality using the prioritization method established by Parker et al. (1996). This prioritization method exhibited some weakness, and a method that considers catchment land use in addition to measured constituent concentration may be more beneficial for implementing effective best management practices throughout the UIRW. The data collected during this study, however, adds to the database of current water quality data for the UIRW, and it represents critical data that is not available widely in the smaller sub-watersheds. This data supplemented with additional data from the HUC 12 watersheds across the UIRW will definitely assist in the determination of watershed priorities.

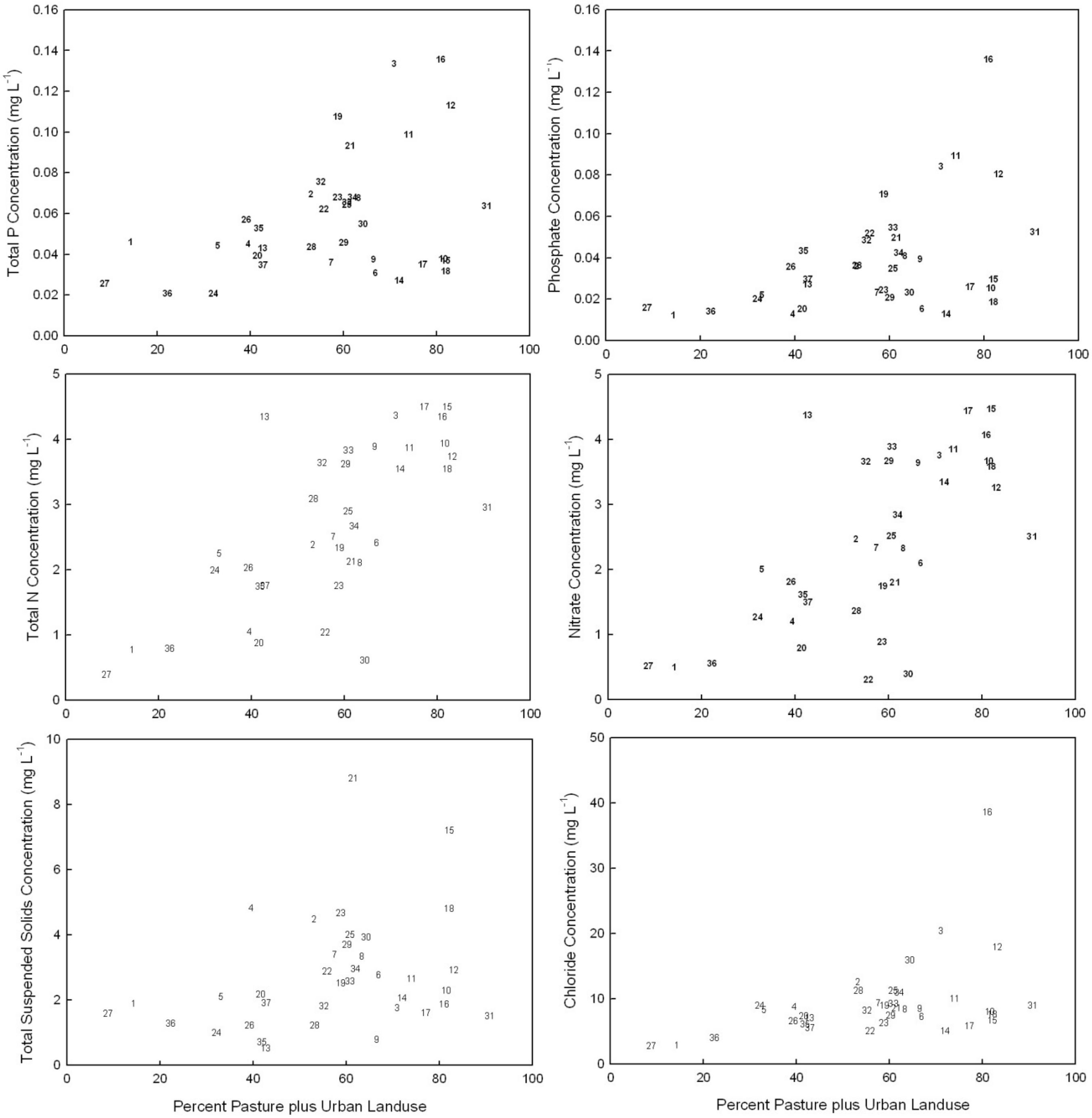

Figure 1. Select constituent concentration along a gradient of pasture plus urban land use within the stream catchments across the Upper Illinois River Watershed, northwest Arkansas.

Table 1. Percentages of forest, urban and pasture land uses in the catchments of the 37 sampled sites in the Upper Illinois River Watershed, northwest Arkansas in 1992 and 2006, and the percentage change in the respective land uses from 1992 to 2006. Positive percent changes indicate an increase in that land use while negative values represent a decrease.

		Forest			Urban			Pasture		
Site No.	Site Name	1992	2006	Δ%	1992	2006	Δ%	1992	2006	Δ%
1	Lake Wedington	76.0	83.1	7.1	0.0	1.9	1.9	21.4	12.3	-9.1
2	Ruby	35.0	45.8	10.8	2.0	6.6	4.6	61.9	46.5	-15.3
3	Goose Creek	17.8	28.0	10.2	10.8	28.4	17.6	70.9	42.6	-28.3
4	Upper Illinois	46.9	59.8	12.9	0.3	3.5	3.2	51.9	36.1	-15.9
5	Hamestring Creek	52.4	66.4	14.0	2.5	13.4	10.9	45.1	19.7	-25.5
6	Clear Creek	21.4	31.3	9.9	18.0	38.7	20.8	58.9	28.2	-30.6
7	Fish	31.4	41.9	10.5	7.0	17.1	10.1	60.4	40.4	-20.0
8	Robinson	25.8	36.3	10.5	7.0	19.8	12.8	65.8	43.5	-22.3
9	Wildcat	20.6	33.5	12.8	0.1	4.5	4.4	79.0	61.7	-17.3
10	Brush	7.6	16.1	8.4	11.1	30.8	19.7	80.4	50.7	-29.7
11	Lower Osage	14.0	24.5	10.5	9.1	24.3	15.2	76.2	49.7	-26.6
12	Upper Osage	7.9	14.5	6.7	22.8	50.8	28.0	68.7	32.3	-36.3
13	Galey	38.4	56.9	18.4	0.0	0.9	0.9	61.4	41.8	-19.7
14	Lick Branch	14.6	27.7	13.2	0.2	3.4	3.2	85.1	68.7	-16.4
15	Little Osage	7.9	17.0	9.1	0.3	10.6	10.3	91.3	71.5	-19.7
16	Spring	9.2	16.1	6.9	21.2	50.1	28.9	68.4	30.9	-37.5
17	Cross	6.5	18.9	12.4	0.5	20.0	19.5	92.6	57.1	-35.5
18	Puppy	8.4	13.5	5.1	12.4	49.7	37.3	77.9	32.4	-45.4
19	Muddy Fork	31.6	39.6	8.0	2.1	5.7	3.7	64.8	53.1	-11.7
20	Blair Creek	47.3	57.2	9.9	0.0	2.4	2.3	51.5	39.2	-12.3
21	Lower Moores	30.7	37.0	6.3	2.3	5.8	3.5	65.7	55.7	-10.1
22	Upper Moores	35.8	42.1	6.3	4.3	9.1	4.8	57.6	46.8	-10.9
23	Kinion	30.7	40.3	9.6	0.0	2.0	2.0	68.8	56.8	-12.0
24	Frances	57.7	67.5	9.7	9.6	17.1	7.5	32.5	15.0	-17.5
25	Gum Springs	26.8	38.0	11.2	6.3	16.2	10.0	66.0	44.6	-21.5
26	Chambers	46.9	60.4	13.5	0.0	1.0	1.0	52.9	38.2	-14.7
27	Pedro	87.6	91.2	3.6	0.0	0.4	0.4	12.3	8.4	-3.9
28	Gallatin	27.2	46.1	18.9	0.1	2.9	2.8	72.5	50.4	-22.1
29	Flint	22.3	39.0	16.7	2.9	7.9	5.0	74.3	52.3	-21.9
30	Little Flint	15.7	30.3	14.6	3.8	10.0	6.2	75.2	54.4	-20.8
31	Sager	3.1	8.5	5.4	16.9	34.0	17.1	79.3	56.8	-22.5
32	Cincinnati	29.9	43.9	14.0	0.1	2.1	2.1	69.3	53.1	-16.2
33	Wedington	25.8	38.8	13.0	0.0	1.5	1.5	73.7	59.3	-14.4
34	Ballard Creek	28.9	37.3	8.5	1.6	5.0	3.4	68.8	57.1	-11.8
35	Baron Fork	47.2	57.7	10.5	0.6	2.6	2.0	51.6	39.3	-12.3
36	Evansville	70.4	77.4	7.0	0.0	0.5	0.5	29.2	21.8	-7.4
37	Fly Creek	45.3	56.7	11.4	0.2	2.0	1.8	54.0	40.9	-13.1

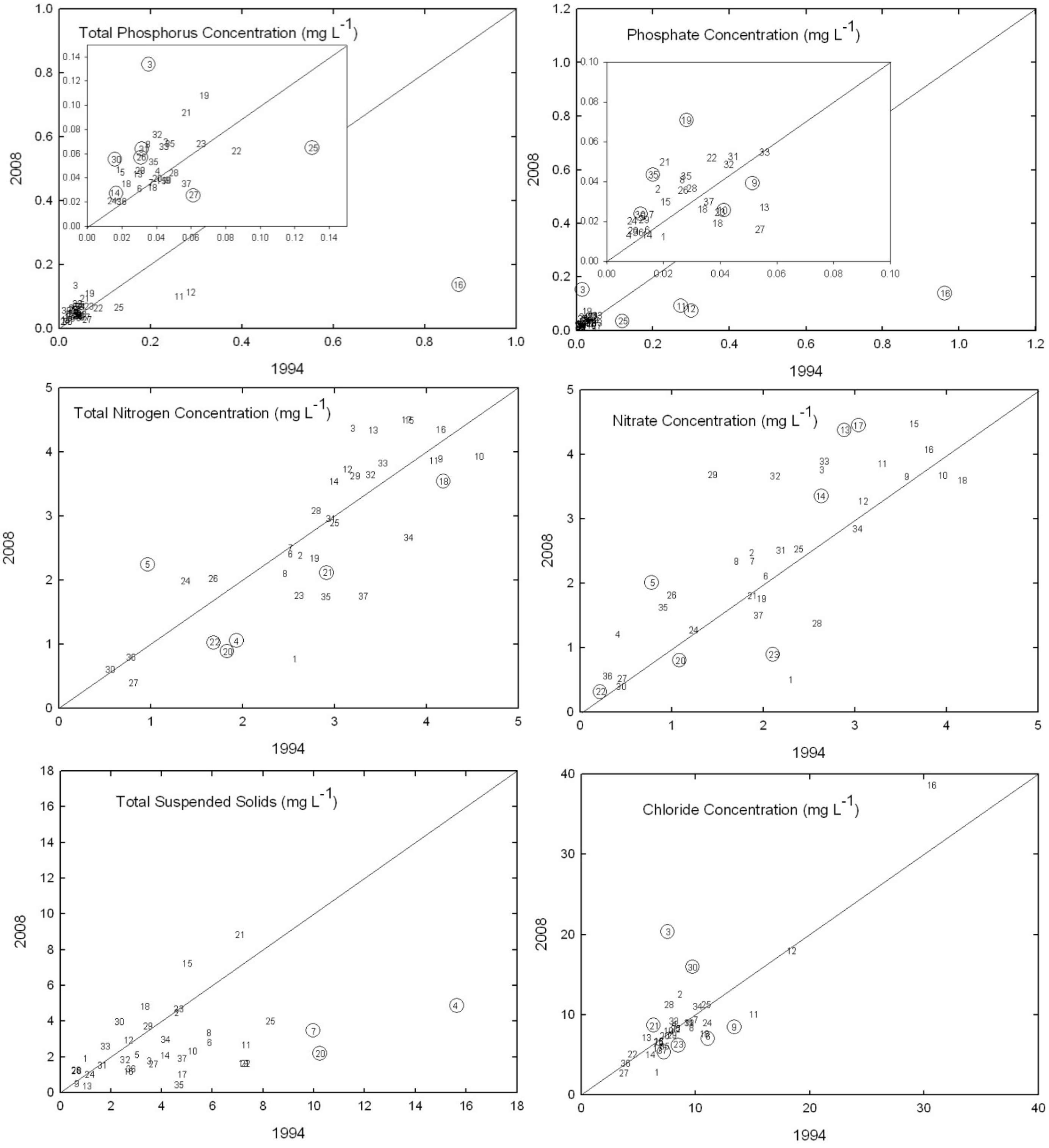

Figure 2. Comparison of select constituent concentrations between Parker et al. (1996) and current data (2008-2009) at 37 sites in the Upper Illinois River Watershed, northwest Arkansas. Circled sites had significantly different (Students t-test, P<0.05) concentrations during the two studies, and the 1:1 line (i.e., diagonal line) allows for simple comparison of geomeans without considering variability in the data.

Table 2. Minimum (Min), geometric mean (Geomean), and maximum (Max) total phosphorus (TP) concentrations during base flow conditions at 37 sites in the Upper Illinois River Watershed, northwest Arkansas, 2008-2009. Current and historical priority rankings were based on base flow geomean concentrations. Following the prioritization method of Parker et al. (1996), 11 sites were ranked as a high priority, 10 sites as a medium priority and 16 sites as a low priority.

Site No.	Site Name	n	Min	Geomean	Max	Base Flow Current Priority	Base Flow Historical Priority	Parker et al. (1996) Unit Load Priority
16	Spring	5	0.068	0.135	0.178	High	High	High
3	Goose Creek	4	0.074	0.133	0.236	High	Medium	Medium
12	Upper Osage	5	0.060	0.113	0.410	High	High	High
19	Muddy Fork	5	0.052	0.107	0.172	High	Medium	High
11	Lower Osage	5	0.070	0.099	0.168	High	High	Medium
21	Lower Moores	5	0.036	0.093	0.162	High	Medium	Medium
32	Cincinnati	5	0.052	0.075	0.166	High	Medium	High
2	Ruby	5	0.054	0.069	0.110	High	Medium	Low
34	Ballard Creek	5	0.042	0.068	0.120	High	High	High
23	Kinion	4	0.051	0.068	0.080	High	Medium	High
8	Robinson	5	0.034	0.068	0.158	High	Medium	Medium
33	Wedington	5	0.046	0.065	0.084	Medium	Medium	Medium
25	Gum Springs	3	0.044	0.064	0.082	Medium	Medium	Medium
31	Sager	5	0.052	0.064	0.084	Medium	Medium	High
22	Upper Moores	4	0.010	0.062	0.190	Medium	Low	Low
26	Chambers	5	0.044	0.057	0.076	Medium	Low	Low
30	Little Flint	5	0.024	0.055	0.254	Medium	Low	Medium
35	Baron Fork	4	0.016	0.053	0.168	Medium	Low	Low
1	Lake Wedington	5	0.014	0.046	0.864	Medium	Medium	Low
29	Flint	5	0.022	0.046	0.074	Medium	Medium	Low
4	Upper Illinois	5	0.026	0.045	0.078	Medium	Medium	High
5	Hamestring Creek	5	0.026	0.044	0.124	Low	Low	Low
28	Gallatin	3	0.026	0.044	0.064	Low	Medium	Low
13	Galey	5	0.036	0.043	0.066	Low	High	Low
20	Blair Creek	5	0.026	0.039	0.068	Low	Medium	Low
10	Brush	5	0.028	0.038	0.050	Low	High	Medium
9	Wildcat	5	0.014	0.038	0.060	Low	High	Low
15	Little Osage	5	0.032	0.037	0.046	Low	High	High
7	Fish	5	0.018	0.036	0.074	Low	Medium	Low
17	Cross	5	0.026	0.035	0.046	Low	High	Medium
37	Fly Creek	5	0.026	0.035	0.056	Low	Medium	High
18	Puppy	5	0.026	0.032	0.044	Low	High	High
6	Clear Creek	5	0.024	0.031	0.040	Low	Medium	Medium
14	Lick Branch	5	0.020	0.027	0.038	Low	Medium	Low
27	Pedro	4	0.018	0.026	0.050	Low	Low	Low
24	Frances	4	0.010	0.021	0.072	Low	Low	Low
36	Evansville	5	0.018	0.020	0.026	Low	Low	Low

Table 3. Minimum (Min), geometric mean (Geomean), and maximum (Max) soluble reactive phosphorus (SRP) concentrations during base flow conditions at 37 sites in the Upper Illinois River Watershed, northwest Arkansas, 2008-2009. Current and historical priority rankings were based on base flow geomean concentrations. Following the prioritization method of Parker et al. (1996), 11 sites were ranked as a high priority, 10 sites as a medium priority and 16 sites as a low priority.

Site No.	Site Name	n	Min	Geomean	Max	Base Flow Current Priority	Base Flow Historical Priority
16	Spring	5	0.105	0.136	0.167	High	High
11	Lower Osage	5	0.055	0.089	0.154	High	High
3	Goose Creek	4	0.040	0.084	0.234	High	Low
12	Upper Osage	5	0.038	0.080	0.374	High	High
19	Muddy Fork	5	0.050	0.071	0.128	High	Medium
33	Wedington	5	0.050	0.054	0.067	High	High
31	Sager	5	0.028	0.052	0.148	High	High
22	Upper Moores	4	0.013	0.052	0.271	High	Medium
21	Lower Moores	5	0.031	0.050	0.071	High	Low
32	Cincinnati	5	0.037	0.048	0.056	High	High
35	Baron Fork	5	0.036	0.043	0.066	High	Low
34	Ballard Creek	5	0.022	0.042	0.064	Medium	Medium
8	Robinson	5	0.020	0.041	0.080	Medium	Medium
9	Wildcat	5	0.032	0.039	0.045	Medium	High
28	Gallatin	3	0.014	0.036	0.059	Medium	Medium
2	Ruby	5	0.025	0.036	0.059	Medium	Low
26	Chambers	5	0.029	0.035	0.048	Medium	Medium
25	Gum Springs	4	0.007	0.035	0.062	Medium	High
15	Little Osage	5	0.018	0.030	0.054	Medium	Low
37	Fly Creek	5	0.018	0.029	0.057	Medium	Medium
13	Galey	5	0.018	0.027	0.036	Medium	High
17	Cross	5	0.012	0.026	0.080	Low	Medium
10	Brush	5	0.021	0.025	0.029	Low	High
23	Kinion	4	0.007	0.024	0.212	Low	Medium
30	Little Flint	5	0.016	0.023	0.028	Low	Low
7	Fish	5	0.006	0.023	0.047	Low	Low
5	Hamestring Creek	5	0.014	0.022	0.048	Low	Low
29	Flint	5	0.013	0.021	0.037	Low	Low
24	Frances	5	0.009	0.020	0.212	Low	Low
18	Puppy	5	0.012	0.019	0.036	Low	Medium
27	Pedro	4	0.006	0.016	0.054	Low	High
6	Clear Creek	5	0.011	0.015	0.035	Low	Low
20	Blair Creek	5	0.008	0.015	0.037	Low	Low
36	Evansville	5	0.010	0.014	0.041	Low	Low
4	Upper Illinois	5	0.009	0.013	0.024	Low	Low
14	Lick Branch	5	0.004	0.013	0.022	Low	Low
1	Lake Wedington	5	0.004	0.012	0.041	Low	Low

Table 4. Minimum (Min), geometric mean (Geomean), and maximum (Max) total nitrogen (TN) concentrations during base flow conditions at 37 sites in the Upper Illinois River Watershed, northwest Arkansas, 2008-2009. Current and historical priority rankings were based on base flow geomean concentrations. Following the prioritization method of Parker et al. (1996), 10 sites were ranked as a high priority, 19 sites as a medium priority and 8 sites as a low priority.

Site No.	Site Name	n	Min	Geomean	Max	Base Flow Current Priority	Base Flow Historical Priority	Parker et al. (1996) Unit Load Priority
17	Cross	5	4.14	4.49	4.88	High	High	High
15	Little Osage	5	3.54	4.49	5.55	High	High	High
3	Goose Creek	4	3.28	4.36	6.28	High	Medium	Medium
16	Spring	5	3.66	4.34	5.08	High	High	High
13	Galey	5	3.80	4.34	4.79	High	High	High
10	Brush	5	3.53	3.92	4.92	High	High	Low
9	Wildcat	5	3.34	3.88	4.18	High	High	Medium
11	Lower Osage	5	3.63	3.86	4.24	High	High	Medium
33	Wedington	5	2.41	3.82	4.76	High	Medium	Medium
12	Upper Osage	5	2.70	3.73	4.90	High	High	High
32	Cincinnati	5	2.92	3.63	4.24	Medium	Medium	High
29	Flint	5	2.99	3.62	4.08	Medium	Medium	Medium
14	Lick Branch	5	3.16	3.54	4.14	Medium	Medium	Medium
18	Puppy	5	3.14	3.53	3.81	Medium	High	High
28	Gallatin	3	2.77	3.08	3.78	Medium	Medium	Medium
31	Sager	5	2.54	2.95	3.73	Medium	Medium	Medium
25	Gum Springs	3	2.61	2.89	3.05	Medium	Medium	Medium
34	Ballard Creek	5	1.33	2.66	4.63	Medium	High	Low
7	Fish	5	2.34	2.50	2.68	Medium	Medium	Low
6	Clear Creek	5	1.97	2.40	3.80	Medium	Medium	Medium
2	Ruby	5	2.04	2.38	2.81	Medium	Medium	Low
19	Muddy Fork	5	1.64	2.33	3.83	Medium	Medium	High
5	Hamestring Creek	5	1.74	2.24	3.63	Medium	Low	Low
21	Lower Moores	5	1.62	2.11	2.70	Medium	Medium	Medium
8	Robinson	5	1.91	2.10	2.39	Medium	Medium	Medium
26	Chambers	5	1.25	2.02	4.42	Medium	Low	Medium
24	Frances	4	1.47	1.98	4.44	Medium	Low	Medium
23	Kinion	4	0.84	1.75	4.63	Medium	Medium	Medium
37	Fly Creek	5	1.12	1.74	3.14	Medium	Medium	Low
35	Baron Fork	4	1.17	1.74	4.21	Low	Low	Medium
4	Upper Illinois	5	0.59	1.04	1.49	Low	Medium	High
22	Upper Moores	4	0.72	1.03	1.36	Low	Low	Low
20	Blair Creek	5	0.53	0.87	1.40	Low	Medium	Low
36	Evansville	5	0.41	0.79	4.50	Low	Low	Low
1	Lake Wedington	5	0.40	0.76	6.28	Low	Medium	Low
30	Little Flint	5	0.03	0.60	2.13	Low	Low	Medium
27	Pedro	4	0.16	0.40	1.31	Low	Low	Medium

Table 5. Minimum (Min), geometric mean (Geomean), and maximum (Max) nitrate-nitrogen (NO_3-N) concentrations during base flow conditions at 37 sites in the Upper Illinois River Watershed, northwest Arkansas, 2008-2009. Current and historical priority rankings were based on base flow geomean concentrations. Following the prioritization method of Parker et al. (1996), 10 sites were ranked as a high priority, 19 sites as a medium priority and 8 sites as a low priority.

Site No.	Site Name	n	Min	Geomean	Max	Base Flow Current Priority	Base Flow Historical Priority
15	Little Osage	5	3.370	4.47	5.56	High	High
17	Cross	5	3.97	4.43	4.75	High	High
13	Galey	5	3.76	4.37	4.71	High	High
16	Spring	5	3.42	4.07	4.63	High	High
33	Wedington	5	2.60	3.88	4.68	High	Medium
11	Lower Osage	5	3.59	3.84	4.46	High	High
3	Goose Creek	4	2.17	3.75	5.58	High	Medium
29	Flint	5	3.42	3.67	4.09	High	Medium
10	Brush	5	3.17	3.66	4.98	High	High
32	Cincinnati	5	2.74	3.65	4.27	High	Medium
9	Wildcat	5	3.32	3.64	4.12	Medium	High
18	Puppy	5	3.00	3.58	4.13	Medium	High
14	Lick Branch	5	3.10	3.34	3.78	Medium	Medium
12	Upper Osage	5	1.75	3.26	4.78	Medium	High
34	Ballard Creek	5	1.83	2.84	4.69	Medium	High
25	Gum Springs	4	1.47	2.52	3.03	Medium	Medium
31	Sager	5	1.71	2.50	3.10	Medium	Medium
2	Ruby	5	2.06	2.46	2.86	Medium	Medium
7	Fish	5	2.13	2.33	2.56	Medium	Medium
8	Robinson	5	1.68	2.33	4.34	Medium	Medium
6	Clear Creek	5	1.75	2.10	2.42	Medium	Medium
5	Hamestring Creek	5	1.88	2.00	2.15	Medium	Low
26	Chambers	5	1.25	1.81	2.52	Medium	Low
21	Lower Moores	5	1.23	1.80	2.37	Medium	Medium
19	Muddy Fork	5	1.27	1.74	2.30	Medium	Medium
35	Baron Fork	5	1.14	1.61	2.49	Medium	Low
37	Fly Creek	5	1.03	1.49	2.02	Medium	Medium
28	Gallatin	3	0.33	1.36	2.77	Medium	Medium
24	Frances	5	1.09	1.26	1.51	Medium	Medium
4	Upper Illinois	5	0.48	1.20	3.60	Low	Low
23	Kinion	4	0.40	0.88	1.34	Low	Medium
20	Blair Creek	5	0.44	0.79	1.11	Low	Medium
36	Evansville	5	0.32	0.55	0.92	Low	Low
27	Pedro	4	0.18	0.51	1.64	Low	Low
1	Lake Wedington	5	0.27	0.49	1.19	Low	Medium
30	Little Flint	5	0.22	0.38	0.67	Low	Low
22	Upper Moores	4	0.16	0.31	0.56	Low	Low

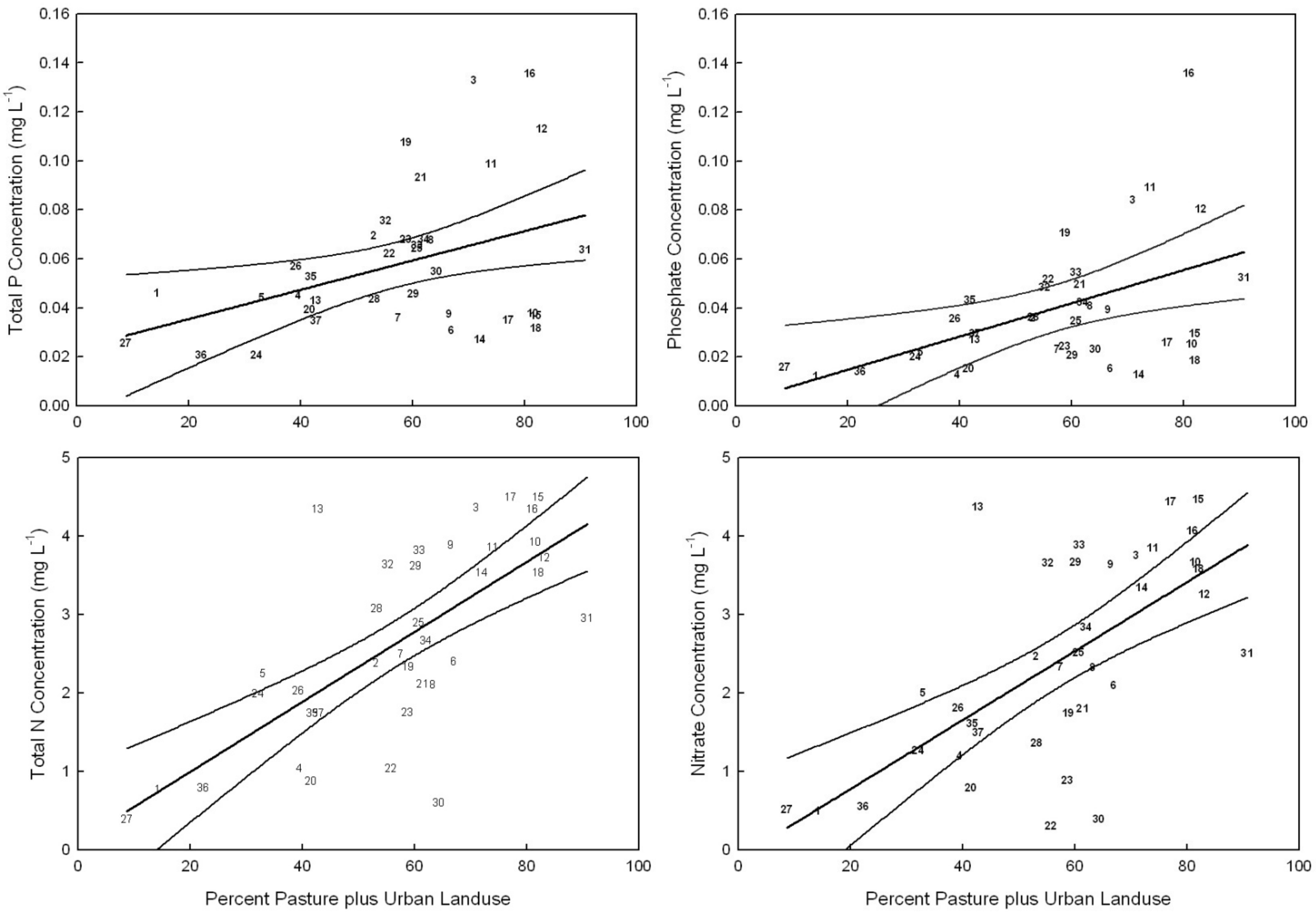

Figure 3. Regression line with 95% confidence interval (i.e., upper and lower curves) about the line of select constituent concentration showing its relationship with pasture plus urban land use within the catchment, Upper Illinois River Watershed, northwest Arkansas.

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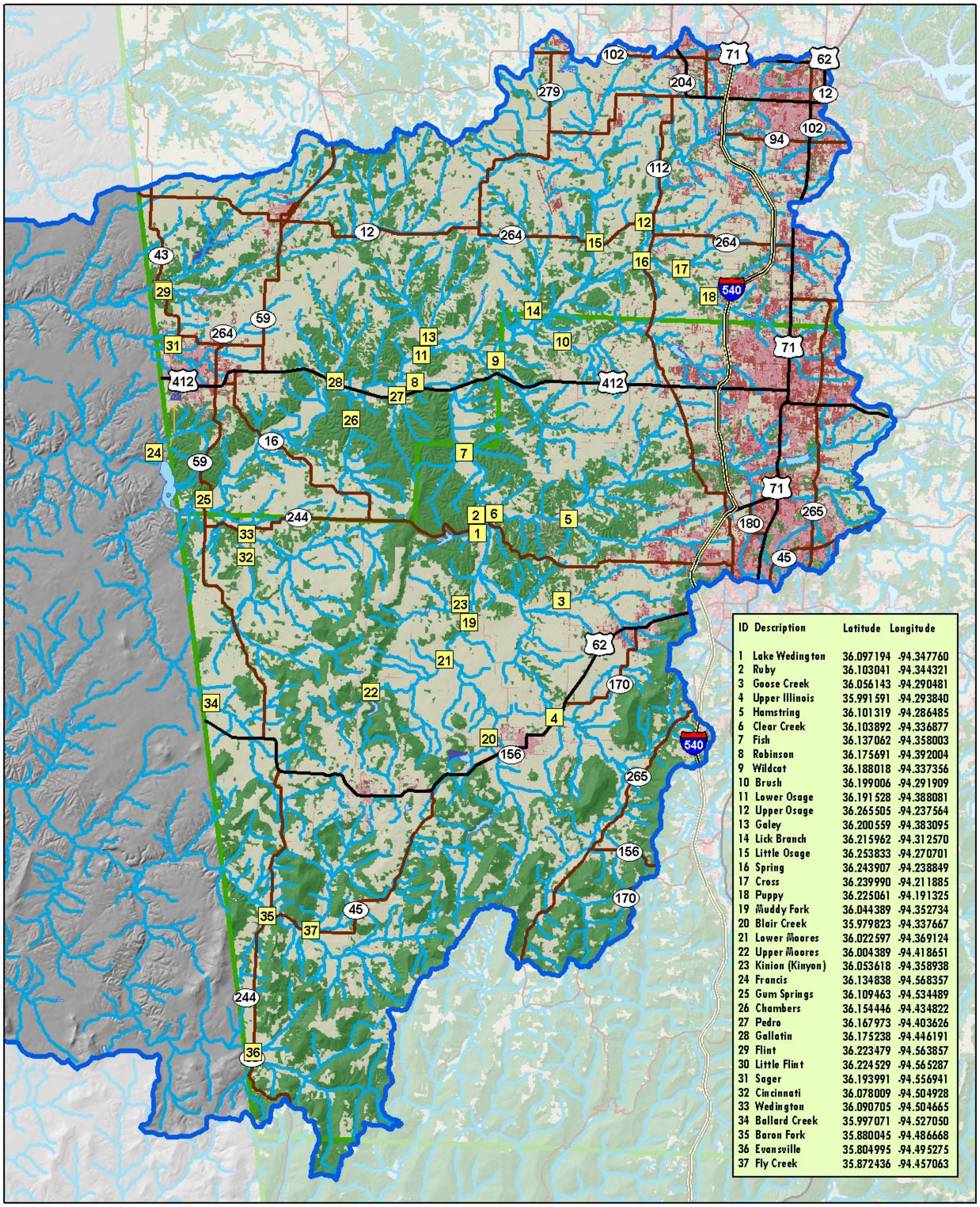
Appendix 1. List of volunteers trained to collect water samples at the respective sampling site.

Site No.	Site Name	River	Volunteer Name
1	Lake Wedington	Illinois River Tributary	T. Bodeker
2	Ruby	Illinois River	R. Edwards
3	Goose Creek	Goose Creek	C. Bushong
4	Upper Illinois	Illinois River	K. McSpadden
5	Hamestring	Hamestring Creek	D. Philipp
6	Clear Creek	Clear Creek	J. Mardis
7	Fish	Illinois River	J. McQuade
8	Robinson	Illinois River	L. Combs
9	Wildcat	Wildcat Creek	B. Masters
10	Brush	Brush Creek	B. Masters
11	Lower Osage	Osage Creek	L. Combs
12	Upper Osage	Osage Creek	M. Saxon
13	Galey	Galey Creek	L. Combs
14	Lick Branch	Lick Branch	S. Bolyard
15	Little Osage	Little Osage Creek	Douglas Farms, D. Douglas
16	Spring	Spring Creek	E. Smith
17	Cross	Cross Creek	T.G. Smith Elementary School, K. Short
18	Puppy	Puppy Creek	T.G. Smith Elementary School, B. Love
19	Muddy Fork	Muddy Fork	UA American Ecological Engineering Society
20	Blair Creek	Blair Creek	Lincoln Schools EAST LAB, T. Ashley
21	Lower Moores	Moores Creek	UA American Ecological Engineering Society
22	Upper Moores	Moores Creek	Arkansas Water Resources Center
23	Kinion (Kinyan)	Kinion Creek	UA American Ecological Engineering Society
24	Francis	Illinois River Tributary	Green County Farms, S. Butler
25	Gum Springs	Gum Springs	Illinois River Watershed Partnership, D. Haak
26	Chambers	Chamber Springs	B. Speer
27	Pedro	Pedro Creek	L. Combs
28	Gallatin	Butler Creek	Arkansas Water Resources Center
29	Flint	Flint Creek	Simmons Foods, M. Simmons
30	Little Flint	Little Flint Creek	Ozark Electronics Repair, Inc., J. Woolbright
31	Sager	Sager Creek	Boy Scout Troop 84, C. Reisbeck
32	Cincinnati	Cincinnati Creek	Illinois River Watershed Partnership, D. Haak
33	Wedington	Wedington Creek	Illinois River Watershed Partnership, D. Haak
34	Ballard Creek	Ballard Creek	Illinois River Watershed Partnership, D. Haak
35	Baron Fork	Baron Fork	J. Smith
36	Evansville	Evansville Creek	Illinois River Watershed Partnership, D. Haak
37	Fly Creek	Fly Creek	G. Pharr

APPENDIX 2. Location of the 37 sampling sites in the Upper Illinois River Watershed, northwest Arkansas based upon the GPS coordinates from Parker et al. (1996).



ID	Description	Latitude	Longitude
1	Lake Wedington	36.097194	-94.347760
2	Ruby	36.103041	-94.344321
3	Goose Creek	36.056143	-94.290481
4	Upper Illinois	35.991591	-94.293840
5	Hamstring	36.101319	-94.286485
6	Clear Creek	36.103892	-94.336877
7	Fish	36.137062	-94.358003
8	Robinson	36.175691	-94.392004
9	Wildcat	36.188018	-94.337356
10	Brush	36.199006	-94.291909
11	Lower Osage	36.191528	-94.388081
12	Upper Osage	36.265505	-94.237564
13	Galey	36.200559	-94.383095
14	Lick Branch	36.215962	-94.312570
15	Little Osage	36.253833	-94.270701
16	Spring	36.243907	-94.238849
17	Cross	36.239990	-94.211885
18	Puppy	36.225061	-94.191325
19	Muddy Fork	36.044389	-94.352734
20	Blair Creek	35.979823	-94.337667
21	Lower Moores	36.022597	-94.369124
22	Upper Moores	36.004389	-94.418651
23	Kinion (Kinyon)	36.053618	-94.358938
24	Francis	36.134838	-94.568357
25	Gum Springs	36.109463	-94.534489
26	Chambers	36.154446	-94.434822
27	Pedro	36.167973	-94.403626
28	Gallatin	36.175238	-94.446191
29	Flint	36.223479	-94.563857
30	Little Flint	36.224529	-94.565287
31	Sager	36.193991	-94.556941
32	Cincinnati	36.078009	-94.504928
33	Wedington	36.090705	-94.504665
34	Ballard Creek	35.997071	-94.527050
35	Baron Fork	35.880045	-94.486668
36	Evansville	35.804995	-94.495275
37	Fly Creek	35.872436	-94.457063